

Mission Pinball Framework Documentation

The Mission Pinball Framework Team

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CHAPTER 1

MPF Overview

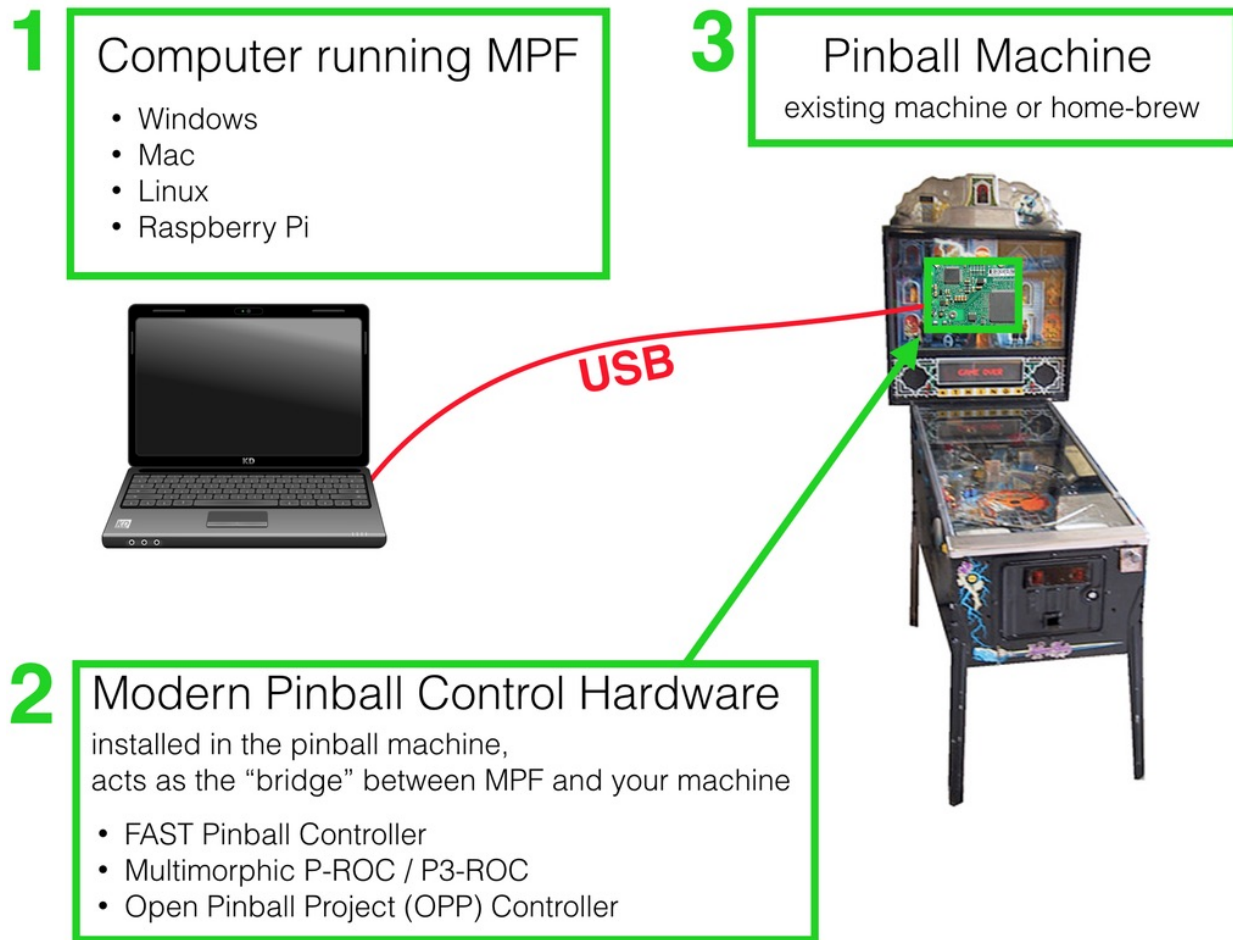
The Mission Pinball Framework (which we call “MPF”) is free and open source software that you run on a computer (Windows, Mac, Linux, Raspberry Pi, etc.) to control a real, physical pinball machine. (More info on what MPF is [here](#).)

Most people develop their game on their laptop, and then when they’re done, transfer it to a smaller computer permanently installed in their pinball machine.

The computer running MPF is connected to a *modern pinball control system* via USB. (MPF supports several different control systems, including FAST Pinball, P-ROC, Open Pinball Project open source hardware, and Stern SPIKE hardware.)

You put that control system in your pinball machine, which can be a custom (home brew) machine or an existing machine you want to reprogram.

This diagram shows how it all fits together:



The MPF software is used to configure and control everything in your machine, including:

- Pinball mechanisms (switches, LEDs, lights, motors, coils, servos, steppers, flippers, ball locks, diverters, etc.)
- Pinball logic (ball locks, multiball, modes, tilt, high scores, ball saves, ball search, extra balls, etc.)
- The display (or displays): DMD, RGB LED, and/or LCD
- Audio & sounds
- Coordinated “shows” of actions which flash lights, fade LEDs, play sounds and video, etc.
- Player management, including player progress, scoring, tracking towards goals, etc.
- Plus lots of other little things that you probably aren’t even thinking about yet :)

Note: MPF is a work-in-progress!

At this point MPF is a work-in-progress and not yet complete. It’s being built by pinball-loving software developers in their spare time. There’s a lot you can do with MPF today, but we also have a lot of work still to do. We’re working hard though, typically adding 20-30 updates per week! And MPF is definitely “done” enough for you to use it today.

Read on to understand other important concepts about MPF:

MPF complete feature list

Even though MPF is a work-in-progress that's not yet complete, the core dev team has been working on it since 2014, with thousands of hours of combined effort.

Major Features & Concepts

- The vast majority of “programming” your game can be done with text-based config files that make it easy to get powerful and complex pinball features running in your game. They're also easy for non-programmers to use.
- MPF is “event-driven” meaning that everything that happens in a pinball machine generates an event, and you can use those events to trigger actions (scoring, lights, starting a mode, etc.)
- Advanced programmers and customization can be done via the API. (The API is fully documented at developer.missionpinball.org.)
- You can easily switch between hardware platforms, so if sometime down the road you want to switch hardware or the company whose hardware you're using goes out of business, all your effort is not lost as you can easily move everything to a new hardware platform with a few changed lines in your config file.

Compatible control systems / electronics

MPF currently interfaces with the following pinball control systems & electronics (which in turn control the physical pinball machine hardware):

- Multimorphic P-ROC & P3-ROC pinball controllers, with either PD-8x8, PD-16, PD-LED, and SW-16 driver and accessory boards or installation in existing WPC, Stern Whitestar, or Stern SAM machines.
- FAST Pinball Core, Nano & WPC controllers, with 3802, 1616, and 0804 I/O boards, FAST servo boards, or installation in existing WPC machines.
- Open Pinball Project (OPP) open source controllers with Gen2 driver boards.
- Stern SPIKE / SPIKE 2 pinball machines.
- Mark Sunnucks's “Snux” System 11 driver board for use in System 11 and Data East machines, in concert with either a P-ROC or FAST WPC controller.
- Fadecandy RGB LED controllers.
- Open Pixel Control (OPC) LED and lighting controllers.
- I2C servo controllers.
- Pololu Maestro servo controllers.
- SmartMatrix RGB LED DMD controllers
- RGB.DMD RGB LED-based DMD controllers

See the [Control Systems / Electronics](#) documentation for full details.

Pinball mechanism support

MPF currently supports the following different types of pinball playfield mechanisms:

- Switches (normally open, normally closed, mechanical or opto, with configurable debounce settings)
- Coils / drivers / solenoids (pulse, enable, disable, PWM)
- Lamp matrix-based incandescent lights & LEDs
- LEDs (RGB, GRB, RGBA, RGBW, RGBAW)
- Accelerometers
- GI (general illumination)
- Flashers
- Flippers
- Pop bumpers / slingshots
- Drop targets and drop target banks
- Diverters
- All forms of troughs (modern, System 11, early WPC, early '80s, Gottlieb System 3, etc.)
- Ball devices (scoops, VUKs, saucers, locks, etc.)
- Multiple playfields and playfield transfers (including head-to-head machines)
- Driver-enabled devices (like flippers and pop bumpers in System 11 machines)
- Mechanical and coil-fired plungers, ball launchers, and catapults
- EM score reels
- Kickbacks
- Magnets
- Rollover switches
- Servos
- Stepper motors
- Traditional motors

See the [Pinball Mechs](#) documentation for full details.

Game logic

MPF includes built-in support for all the pinball machine and game logic you need, including:

- Modes and a mode stack (start / stop / restart / stacked modes)
- Ball locks
- Multiball
- Ball saves
- Ball search

- Extra balls
- Tilt
- Credits / coin play
- Audits
- Bonus
- High score
- Full per-player variable and settings support. Save/restore anything on a per-player bases (shots, objectives, goals collected, targets hit, etc.)
- Player achievements & achievement groups (groups of modes to start which progress towards wizard mode, etc.)
- Ball tracking / automatic ball routing
- Shots & shot groups (with full per-player state management (e.g. lit, unlit, flashing, etc.)
- Shot rotation (lane change, etc.)
- Attract mode
- Logic blocks, which let you build complex pinball game logic out of reusable components via the config files
- Score controller to assign points (or other progress) per-player for different events, with mode integration for blocking and blending
- Timers (start / stop / pause / count down / count up)
- Video modes
- Switch combinations (flipper cancel, hold flipper button to start super skill shot, etc.)
- Timed switches (hold the flipper for 2 seconds to show game stats, etc.)

See the [Game Logic](#) documentation for full details.

Displays, DMDs, & Graphics

- On-screen LCD displays, either high-def or with a “dot” look
- Physical mono-color DMDs
- RGB LED DMDs
- Display “slides” with priorities, transitions in and out
- Display “widgets” (things you put on displays), including:
 - Text (with fonts, styles, colors, dynamic text based on game state, etc.)
 - Images & animated images
 - Videos
 - Shapes
 - “Picture-in-picture” style sub-displays
- Any property of any widget can be animated (opacity, size, position, etc.)

See the [Displays](#) documentation for full details.

Sounds & Audio

- Multi-track sound system with automatic volume and ducking (e.g. voice, sfx, and background music tracks)
- Per-track settings for simultaneous sounds and sound queues (e.g. let as many sfx sounds play at once as you want, but queue sounds on the voice track so only one plays at a time)
- Advanced per-sound “tuning”, including attack, attenuation, ducking, etc.
- Sound pools and sound groups, so you can have multiple sounds for a single effect and cycle through them, with controls for whether they random, weighed random, rotation patterns, etc.

See the [Sounds](#) documentation for full details.

Shows

- A show controller which runs coordinated shows of LEDs, lights, coils, flashers, sounds, slides, videos, animations, etc.
- Start/stop/pause/resume shows
- Dynamic shows which change based on what’s happening in the game.
- Change the playback speed of shows (even while they’re playing)

See the [Shows](#) documentation for full details.

Machine Management

- Service mode / operator menus
- Operator-configurable “settings” which you can use to expose any setting anywhere in MPF to game operators.
- A data manager which handles reading and writing data from disk, including audits, earnings, machine variables, high scores, etc.
- Power supply management (map drivers to power supplies to make sure not too many things fire at once)

Tools

- The [MPF Monitor](#) standalone app which is a graphical tool that connects to a live running instance of MPF and shows the status of various devices. You can interact with it by clicking on switches and see your game in action on your computer.
- An “interactive” media controller which lets you interactively build and test display slides, widgets, and animations.
- A switch player which lets you build automatically scripts to “replay” switches for testing your game.

- A complete set of test functions which you can use to write your own automated tests for your machine.
- A keyboard interface which lets you simulate switch actions with your computer keyboard. (Great for testing!)
- Detailed logging, config file checking, and helpful error messages to help you troubleshoot issues.

Developer-friendly

- Fully open-source and well-documented code.
- A plugin architecture which allows you to write your own plugins to extend baseline functionality.
- Modular design that lets you write your own hardware interfaces.
- A “scriptlet” interface which can be used to easily add Python code snippets to a game to extend the functionality you can get with the configuration files.
- A mode “code” interface which lets you add custom Python code to game modes.

And the best part: Everything mentioned on this page (except for the developer stuff) can be done via the text-based configuration files. If you don’t want to be a “coder,” you don’t have to be. (Though if you are a coder, we’d love to have you help us write MPF!

By the way, if you’d like to see what we have in store for the future, check out our [MPF Road Map, Vision & Future](#).

The MPF “Media Controller”

All modern pinball machines use graphics and sound. MPF’s architecture is build so that the core “game” engine is completely separate from the “media” engine.

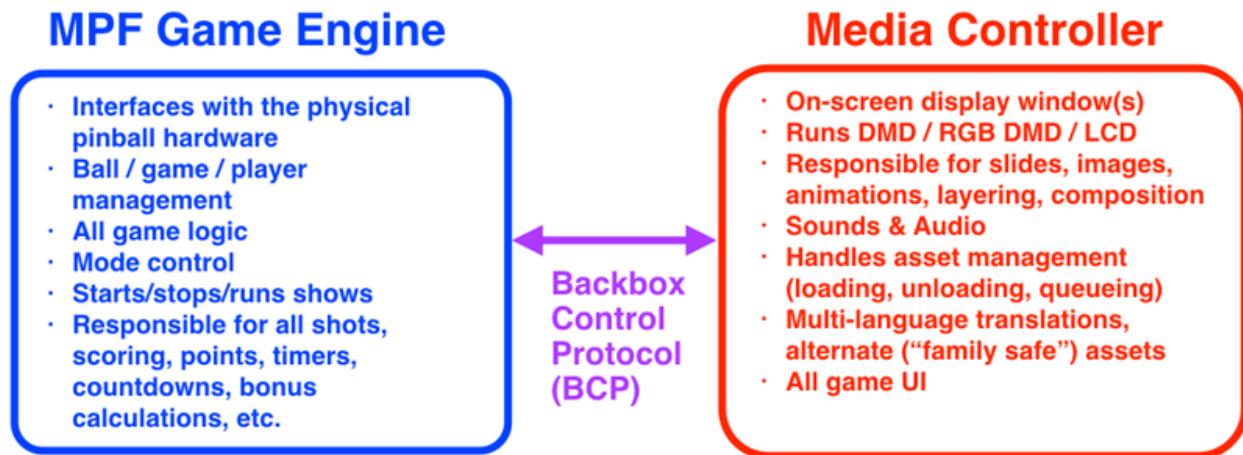
The “game” engine is the MPF software itself, and the “media” engine is something called the MPF Media Controller (which we often abbreviate as “MPF-MC”).

When you run MPF, these two components are two separate processes that talk to each other via something called the “Backbox Control Protocol”.

The details and inner workings of this are not really important, (and frankly they’re mostly hidden from you).

But as you start to learn about MPF, just keep in mind that the part of MPF that runs your game and controls the hardware is separate from the part that shows the graphics and plays the sounds.

Here’s a diagram that shows what each piece does:



More details about MPF's media controller architecture, as well as guides which show you how to run them on separate computers, or even to replace MPF's Media Controller with one based on Unity 3D or something you write yourself, are available in the [Media Controllers](#) section of the documentation.

Understanding MPF config files

MPF uses text-based config files to control the bulk of your game logic. In a sense, your MPF "code" is actually these config files.

There are machine-wide config files which control machine-wide things (such as hardware mappings, switches, lights, etc.) as well as mode-specific config files that control what happens when a specific mode is running. (And you can stack modes so you have a lot of them all doing different things at once.)

MPF also uses text-based files to control the "shows" which are the coordinated sequences of lights, sounds, displays, etc.

The MPF config files use a file format called [YAML](#) which is text-based and human readable. You can edit them in Notepad. YAML is kind of like XML, though easier to read and write. It's kind of like INI files, though more powerful.

We have a [detailed config file reference](#) that explains all the options for all the files, but for now we just want to explain the basic concept of how these files work. (Feel free to browse through the config file reference, but remember that it's a just a reference. You'll actually learn how to use the config files via our tutorial and How To guides. Learning MPF by reading the config file reference is like learning a foreign language by reading a dictionary. :)

When you create your machine code in MPF, you'll actually create a folder which will contain your config files. A super-simple snippet might look like this:

```
game:
  balls_per_game: 3
```

Want a 5-ball game instead? Simple! Just change it:

```
game:
  balls_per_game: 5
```


Ultimately your config files will be thousands of lines long (though you can break them up into multiple files to help your sanity), but again, don’t be overwhelmed now. The tutorial will walk you through them step-by-step, and in no time you’ll have a playing pinball machine!

Config files versus “real” programming

When we talk about MPF, we really play up the fact that when you use MPF, you can do 90%+ of your of your “programming” with MPF’s [YAML configuration files](#).

We’ve received criticism of that over the past few years, typically falling into one of the following categories:

- Since everything in MPF is in config files, that’s something new you have to learn. If you don’t know MPF, you can’t just look at a config file and know what’s happening.
- Since config files insulate the game programmer from the code, when something doesn’t work, you don’t know if it’s your config or a bug in MPF.
- Using config files limits game programmers in that they have to do everything the “MPF way.”
- Coding is fun! MPF deprives people of that.

We understand the motivation behind all these thoughts, so we’d like to provide our perspective on these issues.

You can still code in MPF

MPF does not prevent you from coding. We provide two levels of abstraction to programmers: hardware abstraction and device abstract. If you use a flipper device in code it will expose methods to disable or enable a flipper and work on any hardware which is supported in MPF. Plus the device will manage all the game integration (e.g. disable flipper after the game).

Nevertheless, you might want to implement a different type of flipper (say with three coils each) and the flipper device might be a bad fit. Therefore, you can use the hardware abstraction interface and write rules in a hardware independent way (or overload the flipper device which does exactly that).

If you want to use a very specific feature of your hardware and we did not implement an abstraction for it you can also access the hardware directly but it will likely not work on other platforms anymore. E.g. this might be the case if you want to do advanced stuff with the AUX port on the P-Roc.

As you see, MPF offers you all kind of flexibility. You can access hardware directly or use abstractions. Plus, if you implement your own devices or extend existing devices (those can live inside your machine folder) you will be able to instantiate them using config (if you want that).

Code can be added either globally (using scriptlets or code hooks), per mode, as new/overloaded device or even as a custom platform. See the [MPF developer documentation](#) for more details about our APIs and interfaces.

Why config files?

At the most basic level, config files in MPF let you access hundreds or thousands of lines of code with a simple line or two in a config. The actual code that runs a pinball machine is really, really complex, especially when you think about all the logic around ball tracking, mode stacking, multiple things happening at once, etc.

By providing an interface like the config files, we allow you to have access and to be able to control all these complex things in a simple way.

MPF’s config files are a form of something in computer science called a “domain-specific language. (DSL)”

In this context the “domain” is pinball, so the MPF config files could be thought of as a “pinball-specific language”. This means that you can’t use the MPF DSL to program a dart board machine or a self-driving car, but when it comes to programming pinball, they’re darn good!

There are many advantages to DSLs, including:

- Increased productivity: Get a complex mode up and running in MPF with a half-page config file instead of writing 500 lines of Python code.
- Fewer bugs: The config files are used by lots of people, so we know they work the way they’re supposed to, instead of every pinball maker writing their own stuff from scratch and re-solving the same problems over and over.
- Easier to read: You can look at a few lines of config file and know what you’re looking at and what it’s trying to do versus pages of Python code that you have to reverse engineer to understand.
- Ease of support: Same as above. If you are having a problem, it’s easy to post a config to the forum and everyone can understand it, versus scanning through hundreds of lines of custom Python code.
- Ease of planning: Since everyone in the MPF community speaks the same language of config files, it’s easy to ask for help and direction on how to do things.
- Insulation from future updates: The config files remain constant (or we provide migration tools to upgrade them, so we can make major changes to MPF under the hood without you having to re-write anything in your game.

Config files in MPF: use as much (or as little) as you want

Even though we just laid out the reasons we like “programming” your game via config files instead of “real” code, there’s one important thing to know about the config files:

You don’t have to use config files for everything.

There’s a whole website dedicated to mixing custom code with MPF (at developer.missionpinball.org, and you can easily mix code (written in Python or the language of your choice) with existing MPF code and configs, so really you can use as much or as little of the config file interface as you want.

One way to think about MPF is that it’s a solid set of pinball functionality with a nice API, and then the config file interface is a separate component that rides on top of that API and exposes it via easy-to-use config files.

So if you’re a programmer and prefer to program against the API directly, go for it! The API is well-documented and fairly stable now, so if you don’t want to use a single config file for anything, you can just use the MPF API and do whatever you want and still benefit from the thousands of hours of effort we put into MPF.

The reality, though, is that building a complete game in MPF is a balance between doing things in config files and writing code. At the end of the day, it doesn’t matter whether your game is 90% configs and 10% code, or 80/20, 50/50, 20/80, etc. The exact balance depends on the personal preference of the person building the game.

In fact even we drop into “real” code to do certain things. There have been lots of times when we think, “Yeah, X action would be 20 confusing config lines or just two lines of Python, so I’m writing it in Python.” That’s perfectly fine.

The real power comes when you start to mix-and-match. For example, you could use the MPF config files to build out your base hardware interface and mode structures, then use your own Python code to do the logic within a mode, then use your mode code to post an event to use MPF’s scoring system, etc.

If you don’t use MPF, then you have to write everything yourself in code. If you do use MPF, then you get to choose what you write in code and what you don’t have to write. (Seriously, ball tracking is a hard. Use our pre-written code via the config files!)

I already know Python. Why learn obscure config files?

Again, the software that runs pinball machines is complex. The complete MPF codebase is over 15,000 lines of code, with thousands of lines of code to do things that seem simple on the surface, like managing ball devices and tracking where all the balls are at all times.

MPF’s config files provide a friendly interface to all that complexity. So yes, it’s true that you have to spend a few hours learning about the `ball_devices:` section of the MPF config files in order to learn how to use them effectively. But the alternative is learning everything about how ball tracking works in a pinball machine and then writing all that from scratch yourself. That would take a lot longer than it would to learn about how to configure ball tracking in MPF. And besides, we already did that! :)

Aren’t config files limiting?

Even though we’ve tried to envision many different scenarios and many different types of pinball machines as we built MPF, it’s true that MPF does things a certain way, and the config files are a manifestation of the way MPF does things. So there could be scenarios where you want to do something differently than how MPF does it.

But this does not mean that MPF is not the right framework for you. Don’t throw the baby out with the bath water! If you don’t like the way something works in MPF’s shot management tracking, you don’t have to completely write your own shot management from scratch. Rather you can use MPF’s shot sytem, subclass the methods and objects you want to change, and then tweak them to work in your specific scenario.

Even if you want to completely replace one component of MPF, there hundreds of different components, modules, and systems that go into a pinball machine that are already part of MPF. Unless you want to write all of those from scratch, using MPF lets you get a head start on many of the things that you need in your machine that you don’t want to write yourself.

Coding is fun! Doesn’t using config files deprive me of that?

Some people have said, “I like to code. I don’t want to just build my machine quickly.” Certainly we appreciate that, because we like to code too!

If you decide to write the software for your own pinball machine from scratch, you will spend hundreds of hours writing low-level pinball things, like hardware device management, ball tracking, a mode queue, player objects, a display and sound system, etc.

If you use MPF, even if you write your own game logic in Python code, then you can focus on the fun stuff while the MPF developers focus on the boring low-level pinball stuff.

Of course, if you’re thinking, “But I *like* the low-level stuff, I want to write that,” then we would love to have you on our team helping to make MPF better. :) We have a to-do list for MPF which will take years to complete, so if you like to code, we’d love to have you help!

If there’s something that MPF does that you don’t like and that you think you can do better, that’s an even better reason to contribute back to MPF. Please, help us make MPF better!

We have success stories of this already. Brian Madden and Gabe Knuth started writing MPF in 2014. Since then, MPF user Jan Kantert started using MPF, and then he started tweaking things here and there (and submitting his changes back to the MPF project.) Now Jan has completely rewritten MPF’s ball device code, our hardware platform interface, he’s added multiball, ball lock, and ball search, extra balls, servos, tests. . . the list goes on.

Another MPF user, Quinn Capen, has rewritten MPF’s RGB LED interface, written a complete pinball-focused advanced audio system, written an alternative media controller based on Unity 3D. . .

John Marsh said, “It would be cool if there was a GUI wizard to help people set up their machines,” so now he’s building that.

Hugh Spahr created his own pinball controller hardware (the Open Pinball Project), and then wrote a platform interface for MPF so MPF users can use OPP hardware too.

You get the idea.

The bottom line is that these are all MPF users who love to code, so rather than being scared away by MPF’s config file interface, instead they embraced MPF, dug in, and are making MPF better. So now all the time they spend writing code isn’t just limited to running on their machine which sits in their basement for 360 days a year; instead their code is running on pinball machines all over the world, which is very fulfilling and cool!

When something breaks, I don’t know if it’s my config or an MPF bug?

True, one of the limitations of using config files is that when things don’t work the way you expect, you don’t know if it’s a problem with your config or a deeper bug in MPF.

However if you’re someone who knows how to program, MPF is open source! You can go through the MPF code to see if it’s a bug, and if so, you can fix it and submit a pull request to fix that bug for everyone.

And if it’s a configuration error, you can also edit the MPF documentation to be more clear, and then submit a pull request to the docs, and now you’ve also helped fix this issue for everyone.

Again, don’t not use MPF because it uses config files and you want to “know” what’s happening under the hood. Instead learn MPF and the code behind it and share your programming and pinball passion with the world!

Using MPF means you have a team of programmers making your machine better

The MPF project was started in May 2014. Since then we have over 5,000 hours of time spent (both in code and documentation). More importantly, we’re continuing to update and expand MPF, with dozens of commits to the core code and docs every week. (Probably an average of 60 hours a week of work.)

If you use MPF, you get all that work for free. :) It’s like having a team of developers working 60 hours a week to make your game better. Pretty cool!

The bottom line

The creators of MPF are passionate about pinball, passionate about software development, and passionate about open source.

The beauty of MPF is that it’s a bunch of people, from all over the world, writing software and documentation which helps more people create more pinball machines. As MPF grows in popularity, we love the fact that some day we will be able to walk into a bar, see a pinball machine, and know that some of the code we wrote is powering that machine. It warms our hearts.

If you decide to go your own way and not use MPF, that’s great. We support you! (Feel free to rip off any ideas from MPF. We’d love it!) But don’t write off MPF just because you want to do “real” programming and MPF is a “config-based” project. We could use the help of programmers like you. :)

Compatible Pinball Machines

If you haven't done so already, be sure to read the [MPF Overview](#) page to understand how MPF talks to physical pinball machines.

There are three options when it comes to using MPF with a pinball machine:

- Build your own new machine completely from scratch.
- Rewrite the rules for an existing machine, which means you don't change the physical hardware at all, rather, you just update the software.
- “Retheme” an existing machine, which means you reuse all of the mechanical and electrical components of an existing machine, but you strip down and replace all the artwork to transform it into something else. (And you rewrite all the rules for your new theme.)

Here are more details on each option. The “rewrite the rules” and “retheme” options above are combined below into the “controlling an existing machine” section:

Controlling a custom “home brew” machine with MPF

If you want to use MPF to power a new *custom* pinball machine that you build yourself, you can buy new custom driver boards from the same people who make the P-ROC, FAST, or OPP Pinball controllers.

Details for how to build custom machine hardware are covered on the [PinballMakers.com Wiki](#).

Controlling an existing machine with MPF

If you want to use MPF to write your own custom game code for an *existing* Williams or Stern pinball machine, you replace the original CPU board in the machine with a modern pinball controller board (called a *hardware controller*) such as a [P-ROC](#) or [FAST](#) Controller. That hardware controller

interfaces with the existing machine’s driver boards to control the coils, lights, and DMD, and it provides a “bridge” (via USB) to a host computer running Python and the Mission Pinball Framework.

Machine Type	P-ROC	FAST	LISY	Direct
Williams / Bally / Midway WPC	X	X		
Williams / Bally System 11	X	X		
Data East	X	X		
Stern S.A.M.	X			
Stern Whitestar	X			
Stern SPIKE / SPIKE 2				X
Gottlieb System 1			X	
Gottlieb System 80			X	

Notes:

- “WPC” includes WPC-S and WPC-95, and machines made under the brands of Williams, Bally, and Midway. (A complete WPC game list is [here](#).)
- System 11 and Data East machines require the “*Snux*” replacement driver board in addition to the P-ROC or FAST controller.
- Since Stern SPIKE systems have a linux-based computer inside them already, so *MPF can directly connect to and control them via USB*. No additional hardware is needed.
- Gottlieb System 1 and 80 can be controlled using the *LISY platform*

If you want to use MPF with an existing machine type that’s not on the list above, that’s still possible, but you’d have to rewire the entire machine and use modern control hardware. In other words, you strip the guts and keep all the hardware, and the machine essentially becomes a home-brew machine on the inside and a retheme or update on the outside. However, there might be an alternative not listed here so we recommend you to ask in our [user forum](#).

Downloading & Installing MPF

Installing MPF is fairly straightforward. It can be used on Windows, Mac, or Linux, on both Intel x86 and ARM processors, and in 64-bit and 32-bit systems.

Installing MPF for the first time

We've created step-by-step installation guides which walk you through the entire process. Select the OS you're using from the list below:

Installing MPF on Windows

MPF can be used on Windows 7, 8, and 10, in both 32-bit and 64-bit versions. The installation process is pretty much automated, and the whole thing should only take a few minutes.

Here are the steps:

1. Install Python 3.4 (not Python 3.5 or 3.6)

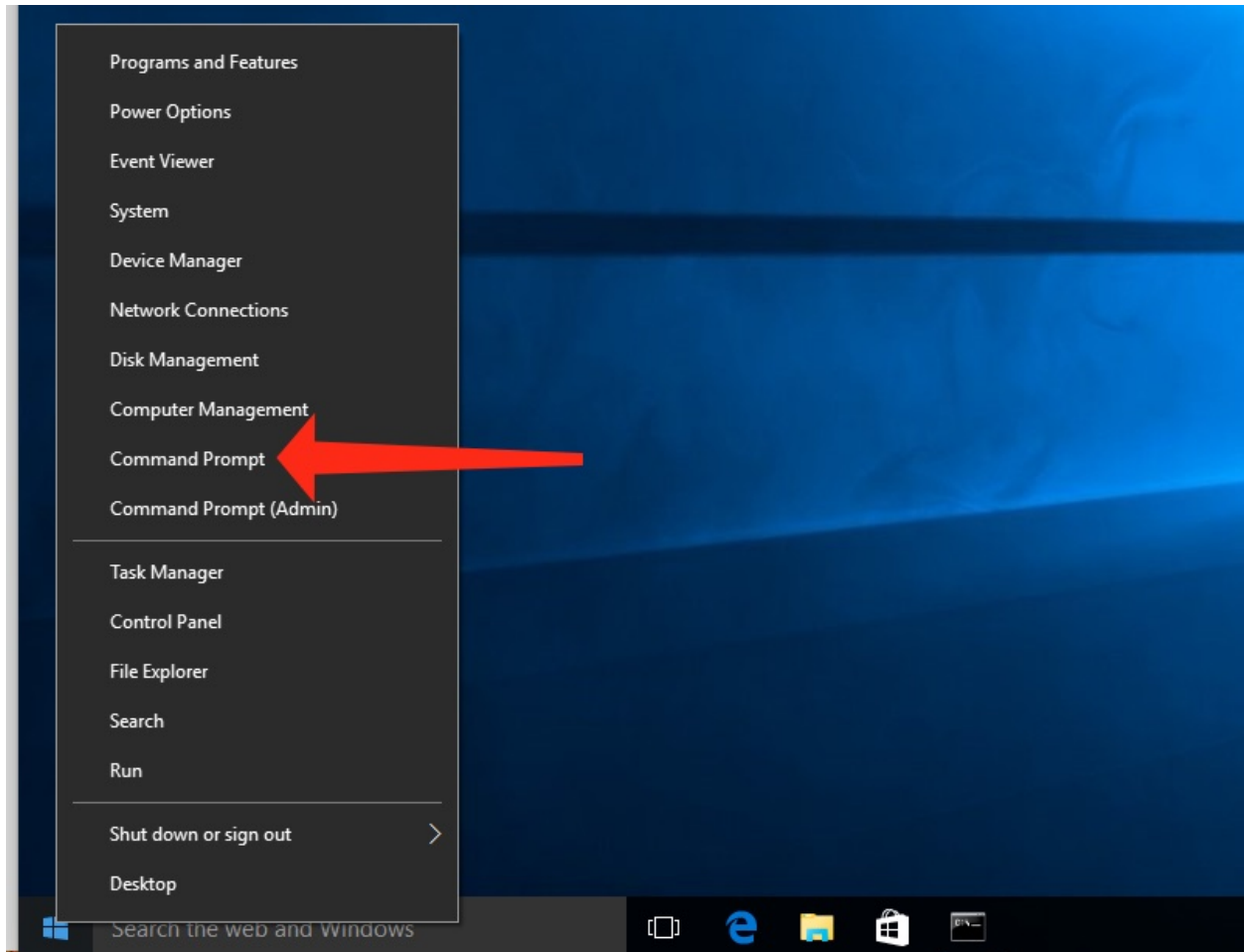
MPF is written in a computer language called "Python". This means you have to install Python first before you can use MPF. Luckily this is just a one-time install, and you don't have to install it again if you update MPF later.

On Windows platforms, MPF requires Python 3.4, (Python 3.5 and newer will not work). You can download and install from the Python website. (Keep reading for links)

Warning: To be very clear, on Windows, MPF requires Python 3.4. It will not run on Python 3.5+.

There are two versions of Python, a 32-bit version and a 64-bit version, and you should pick the one that matches the version of Windows you're using.

To find out whether you have 32-bit or 64-bit Windows, open a command prompt by right-clicking on the Windows button and selecting "Command Prompt" from the menu:

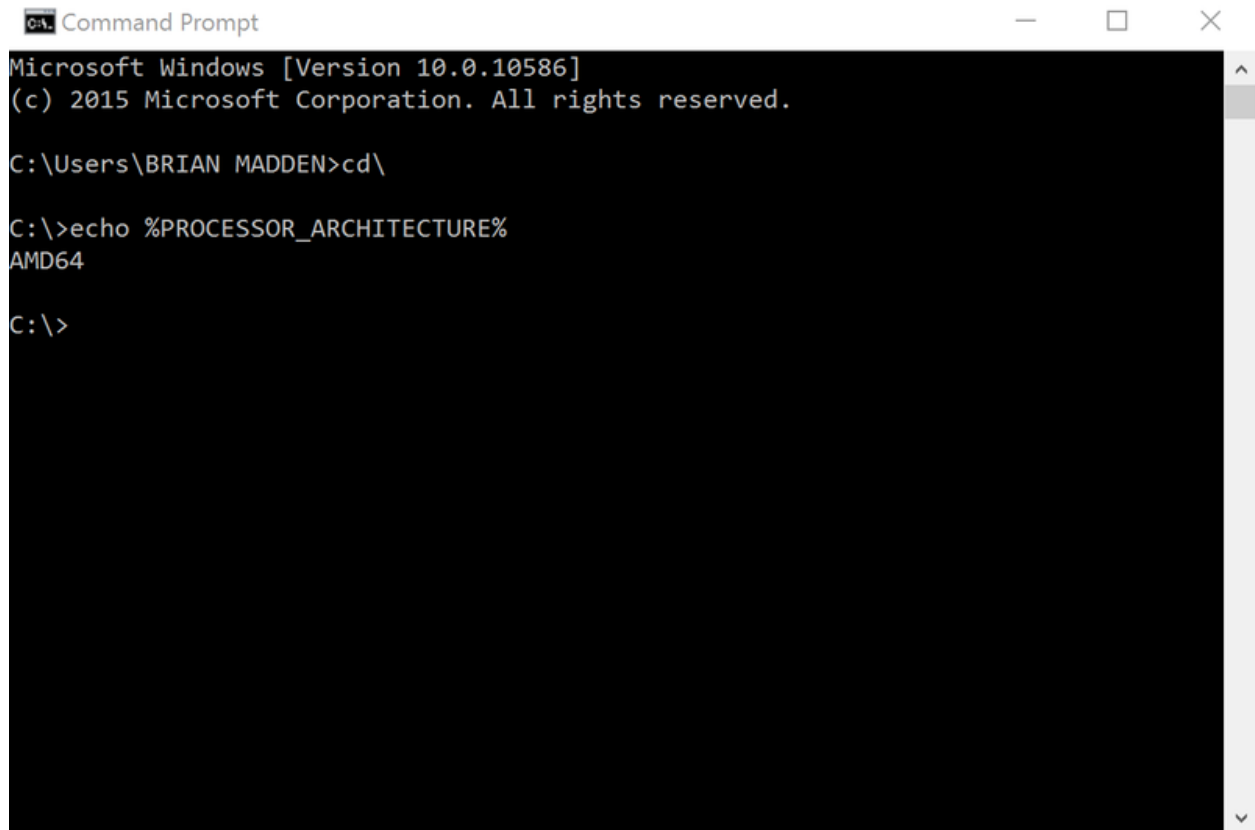


Then inside that window, type the following command and press Enter. This command is case-sensitive, so copy it exactly:

```
echo %PROCESSOR_ARCHITECTURE%
```

If it prints x86, that's 32-bit. If it prints x64 or AMD64, that's 64-bit. (Note that it might print "AMD64" even if you have an Intel processor.)

Here's an example of running this on a 64-bit Windows 10 machine:



```
Command Prompt
Microsoft Windows [Version 10.0.10586]
(c) 2015 Microsoft Corporation. All rights reserved.

C:\Users\BRIAN MADDEN>cd\

C:\>echo %PROCESSOR_ARCHITECTURE%
AMD64

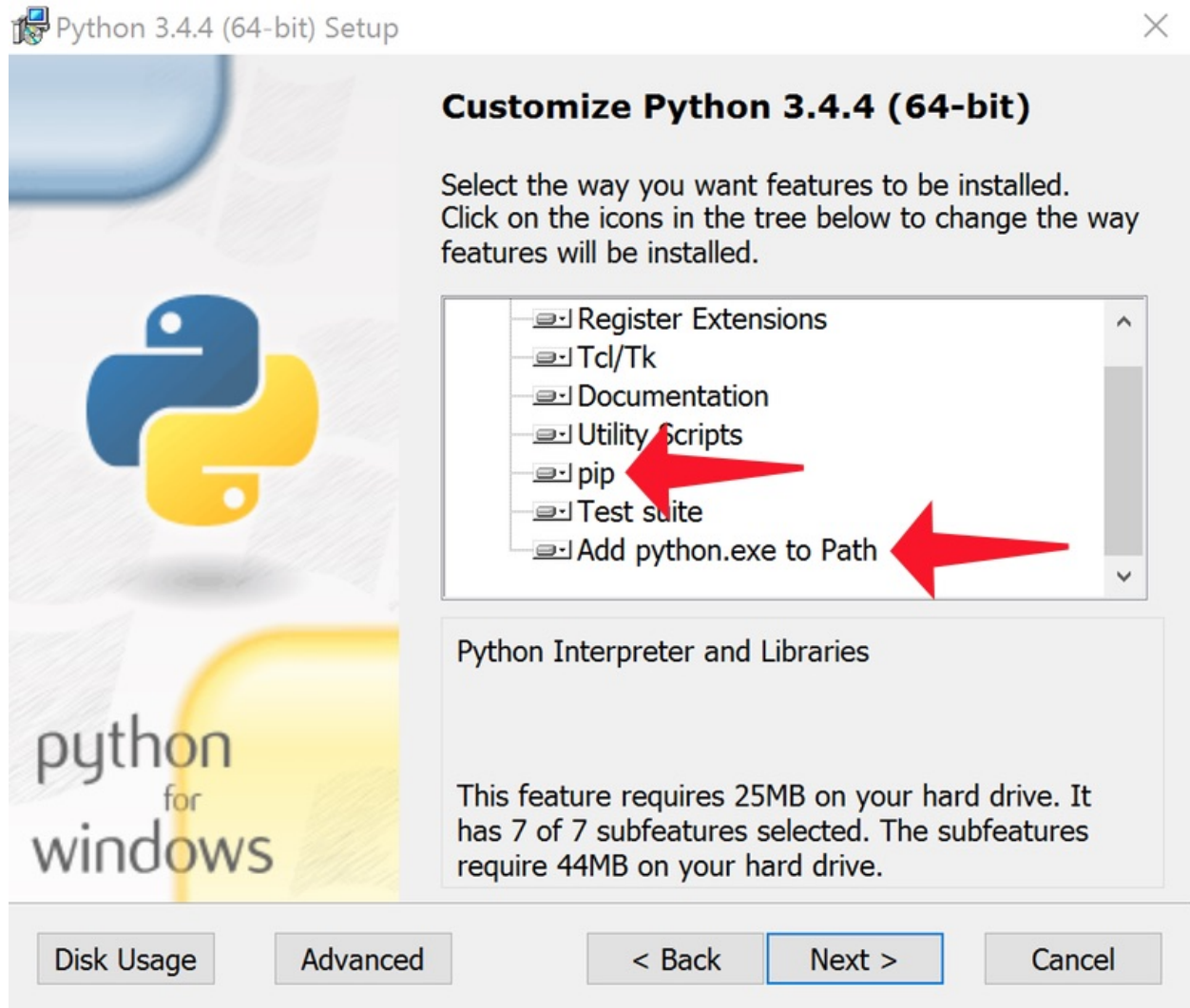
C:\>
```

Then go to the Python website download the version you need. (Note that the final digit in the Python version number is the “patch” number, so 3.4.4 is the latest version of Python 3.4.) Or use the direct-download links here:

- [For 32-bit \(x86\) Windows](#)
- [For 64-bit \(x64 or AMD64\) Windows](#)

Installing Python 3.4 is pretty straightforward. It’s a normal Windows installer.

The only thing you should change from the defaults is on the “Customize Python 3.4.4” screen, we like to select the option “Add python.exe to Path”. That way you can run python from any folder, rather than having to specify the full path to it. (Also make sure the “pip” option is selected, but that should be selected by default.)

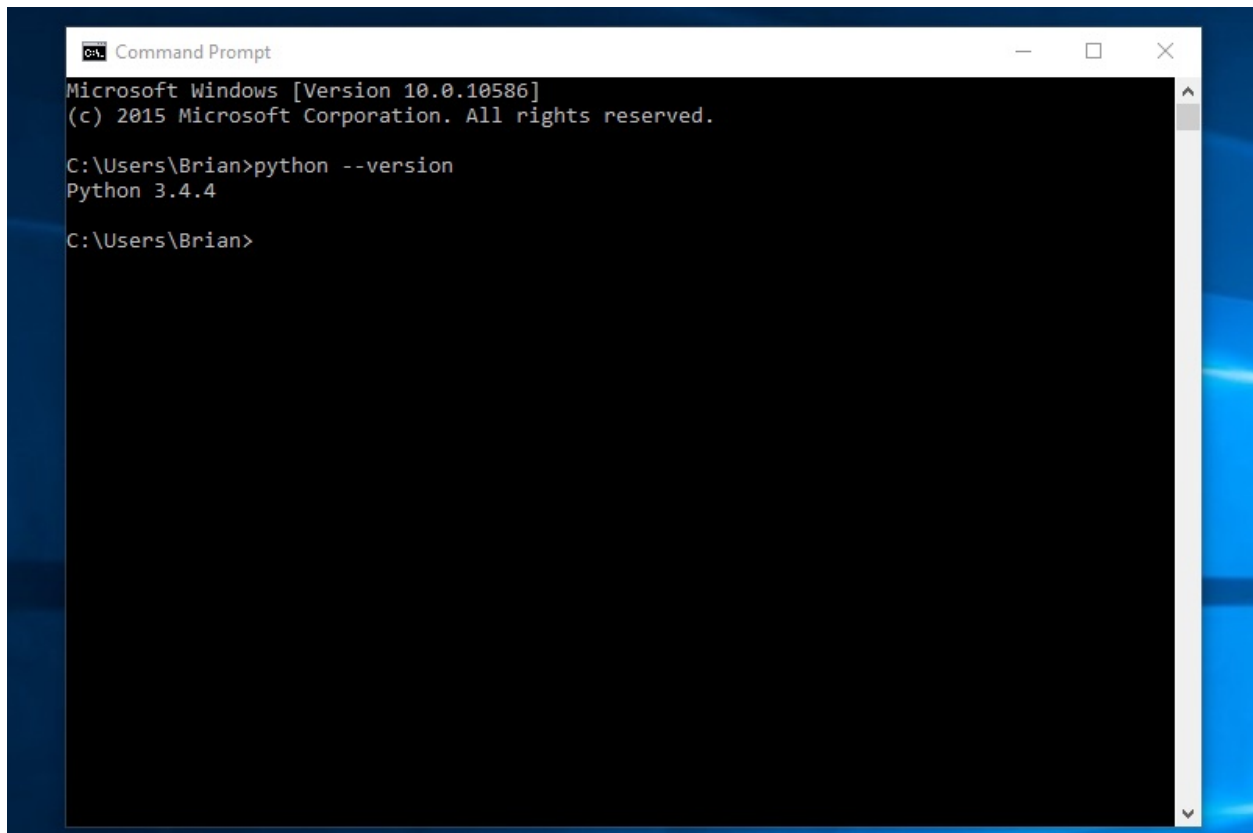


Note that you have to log out and then log back in for the path to be updated once you install Python. If you don't, then you'll get an error about Python not being found when you try to install MPF.

After you log out and log back in, (or just restart your computer), open a command prompt again and type the following command, then press ENTER: (note there are two dashes before the word "version")

```
python --version
```

That should print which version of Python is installed, like this:

A screenshot of a Windows Command Prompt window. The title bar says 'Command Prompt'. The text inside the window reads: 'Microsoft Windows [Version 10.0.10586] (c) 2015 Microsoft Corporation. All rights reserved. C:\Users\Brian>python --version Python 3.4.4 C:\Users\Brian>'. The window has standard Windows window controls (minimize, maximize, close) in the top right corner.

Make sure the version is Python 3.4.4. If you see a version number that starts with 2, that means you also have Python version 2 installed. (This is ok. You can have Python 2 and Python 3 installed at the same time.) However, if this is your case, you need to use a different command to start Python 3. See the [2_and_3](#) page for details.

2. Upgrade pip

Python includes a utility called “pip” which is the name of the Python Package Manager. Pip is used to install Python packages and applications from the web. (It’s kind of like an app store for Python apps.)

So the next step is to update the “pip” program itself to make sure you have the latest one. It’s not really important to know exactly what this means right now, just run it.

```
pip install pip --upgrade
```

This command will upgrade pip to the latest version which should be 9 or newer.

Note that if you’re running the command prompt *without* admin rights, you might get some red text and a permissions error, but that’s ok. You can run the following command to show the version of pip (and the packages you have installed) like this:

```
pip list
```

That will print out something like this:

```
C:\Users\BRIAN MADDEN>pip list
pip (9.0.1)
```



```
setuptools (18.2)

C:\Users\BRIAN MADDEN>
```

Notice that pip is now version 9.0.1 (or later, depending on the latest version when you're doing this), and not the 7.x version that came with Python 3.4.4.

3. Install MPF

Now that Python is installed and pip is up-to-date, it's time to install MPF! To do this, run the following command from the command prompt:

```
pip install mpf-mc
```

This command is telling pip to install a package called “mpf-mc”, which is the *Mission Pinball Framework - Media Controller* package. When you run this, pip will connect to the internet and download MPF-MC from the Python app store and install it onto your computer.

Pip packages can include dependencies, which means that when you run this command, you'll see a bunch (like 10 or so) packages get downloaded and installed. The total size of all these will be almost 200mb, and they include multimedia libraries, graphics engines, codecs, and a bunch of other components that MPF needs.

The MPF MC package will also download and install the MPF game engine package.

Here's an example of what this looks like from the command prompt. (Note that the exact versions and sizes might not be the same as what you have, but this should give you a general idea. Also this may take a few minutes to run on your computer.)

```
C:\Users\BRIAN MADDEN>pip install mpf-mc
Collecting mpf-mc
  Downloading mpf-mc-0.32.11-cp34-none-win_amd64.whl (11.3MB)
    100% |#####| 11.3MB 58kB/s
Collecting kivy==1.9.1 (from mpf-mc)
  Downloading Kivy-1.9.1-cp34-none-win_amd64.whl (7.6MB)
    100% |#####| 7.6MB 114kB/s
Collecting kivy.deps.sdl2==0.1.17 (from mpf-mc)
  Downloading kivy.deps.sdl2-0.1.17-cp34-cp34m-win_amd64.whl (2.5MB)
    100% |#####| 2.5MB 284kB/s
Collecting ruamel.yaml<0.11,>=0.10 (from mpf-mc)
  Downloading ruamel.yaml-0.10.23-py3-none-win_amd64.whl (69kB)
    100% |#####| 71kB 1.1MB/s
Collecting pypiwin32 (from mpf-mc)
  Downloading pypiwin32-219-cp34-none-win_amd64.whl (8.6MB)
    100% |#####| 8.6MB 75kB/s
Collecting kivy.deps.glew==0.1.9 (from mpf-mc)
  Downloading kivy.deps.glew-0.1.9-cp34-cp34m-win_amd64.whl (161kB)
    100% |#####| 163kB 1.3MB/s
Collecting kivy.deps.sdl2-dev==0.1.17 (from mpf-mc)
  Downloading kivy.deps.sdl2-dev-0.1.17-cp34-cp34m-win_amd64.whl (3.5MB)
    100% |#####| 3.6MB 242kB/s
Collecting kivy.deps.gstreamer==0.1.12 (from mpf-mc)
  Downloading kivy.deps.gstreamer-0.1.12-cp34-cp34m-win_amd64.whl (129.5MB)
    100% |#####| 129.5MB 6.9kB/s
Collecting mpf>=0.32.6 (from mpf-mc)
```



```

Downloading mpf-0.32.6-cp34-none-any.whl (746kB)
 100% |#####| 747kB 819kB/s
Collecting Kivy-Garden>=0.1.4 (from kivy==1.9.1->mpf-mc)
  Downloading kivy-garden-0.1.4.tar.gz
Collecting ruamel.base>=1.0.0 (from ruamel.yaml<0.11,>=0.10->mpf-mc)
  Downloading ruamel.base-1.0.0-py3-none-any.whl
Collecting pyserial>=3.2.0 (from mpf>=0.32.6->mpf-mc)
  Downloading pyserial-3.2.1-py2.py3-none-any.whl (189kB)
 100% |#####| 194kB 1.6MB/s
Collecting pyserial-asyncio>=0.2 (from mpf>=0.32.6->mpf-mc)
  Downloading pyserial_asyncio-0.3-py3-none-any.whl
Collecting requests (from Kivy-Garden>=0.1.4->kivy==1.9.1->mpf-mc)
  Downloading requests-2.12.4-py2.py3-none-any.whl (576kB)
 100% |#####| 583kB 1.1MB/s
Installing collected packages: requests, Kivy-Garden, kivy, kivy.deps.sdl2, ruamel.base,
ruamel.yaml, pypiwin32, kivy.deps.glew, kivy.deps.sdl2-dev, kivy.deps.gstreamer, pyserial,
pyserial-asyncio, mpf, mpf-mc
Running setup.py install for Kivy-Garden ... done
Successfully installed Kivy-Garden-0.1.4 kivy-1.9.1 kivy.deps.glew-0.1.9 kivy.deps.gstreamer-0.1.12
kivy.deps.sdl2-0.1.17 kivy.deps.sdl2-dev-0.1.17 mpf-0.32.6 mpf-mc-0.32.11 pypiwin32-219 pyserial-3.2.1
pyserial-asyncio-0.3 requests-2.12.4 ruamel.base-1.0.0 ruamel.yaml-0.10.23

C:\Users\BRIAN MADDEN>

```

If you want to make sure that MPF was installed, you can run:

```
mpf --version
```

This command can be run from anywhere and should produce output something like this:

```

C:\Users\BRIAN MADDEN> mpf --version
MPF v0.32.6

```

(Note that the actual version number of your MPF installation will be whatever version is the latest.)

4. Download & run the “Demo Man” example game

Now that you have MPF installed, you probably want to see it in action. The easiest way to do that is to download a bundle of MPF examples and run our “Demo Man” example game. To do that, follow the instructions in the [How to run “Demo Man”, an MPF example game](#) guide.

There’s another example project you can also check out if you want called the “MC Demo” (for media controller demo) that lets you step through a bunch of example display things (slides, widgets, sounds, videos, etc). Instructions for running the MC Demo are [here](#).

5. Install whatever drivers your hardware controller needs

If you’re using MPF with a physical machine, then there will be some specific steps you’ll need to take to get the drivers installed and configured for whatever control system you’ve chosen. See the [control systems](#) documentation for details. (You don’t have to worry about that now if you just want to play with MPF first.)

Running MPF

See the section *How to start MPF and run your game* for details and command-line options.

Keeping MPF up-to-date

Since MPF is a work-in-progress, you can use the *pip* command to update your MPF installation.

To to this, run the following:

```
pip install mpf mpf-mc --upgrade
```

This will cause *pip* to contact PyPI to see if there's a newer version of the MPF and MPF MC (and any new requirements). If newer versions are found, it will download and install them.

Next steps!

Now that MPF is installed, you can follow our *step-by-step tutorial* which will show you how to start building your own game in MPF!

Installing MPF on Mac

MPF can be used on Mac OS X 10.9 and newer, including Mavericks, Yosemite, El Capitan, and MacOS Sierra.

Note: MPF cannot run in a Mac virtual machine (like in VMware Fusion or Parallels) if the guest OS is Mac, though running MPF in a Windows or Linux VM on a Mac is fine.

Also at this time, installing all the components you need to run MPF on a Mac will require almost 2 GB of disk space. MPF itself it only about 12 MB, but there are a lot of supporting things that MPF needs as you'll see here.

We have a video which shows this entire installation process in action which is available at <https://www.youtube.com/watch?v=lJEfQGffXsA>

Here are the steps to install MPF on a Mac:

Step 0. Uninstall your previous MPF app installation

The process for running MPF on a Mac has changed as of Jan 10, 2017. Previously we had an MPF.app that you downloaded which contained Python and everything you needed.

If you used MPF on a Mac prior to this and you have the MPF.app, you need to remove it first. If you have never installed MPF on your Mac before, then proceed directly to Step 1 below.

To remove the old MPF Mac installation:

1. Delete the "MPF.app" from your Applications folder.
2. Delete the "mpf" alias in /usr/local/bin.
3. Delete the "kivy" alias in /usr/local/bin.

If you don't know how to find your `/usr/local/bin` folder, you can use the “Go to Folder” technique shown in Step 1.

1. Download the Mac Multimedia Frameworks

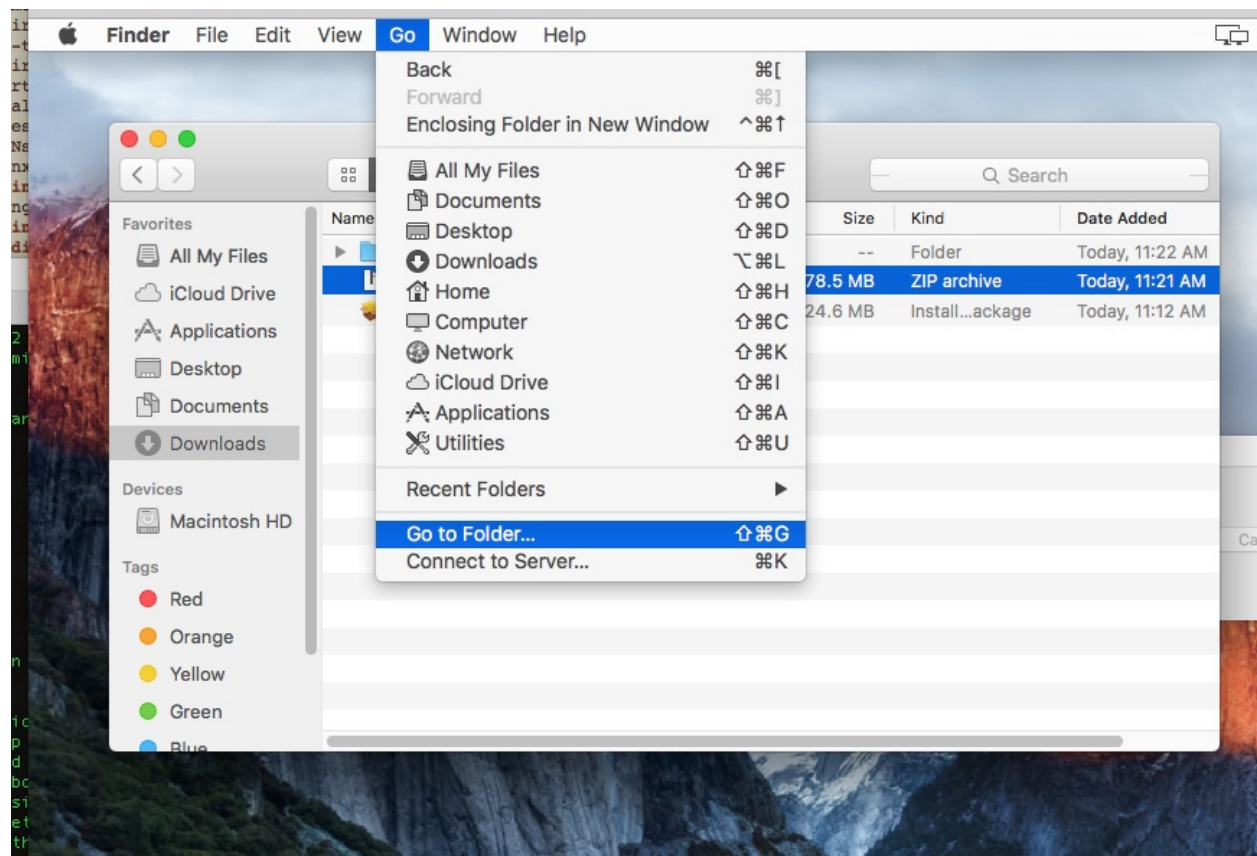
MPF uses open source multimedia frameworks called GStreamer and SDL2 for its graphics, video, and sound features. So next you need to download these frameworks and copy them to your Mac's frameworks folder. There are actually five different frameworks MPF needs, and downloading them all separately is kind of a pain (especially finding the right versions and everything), so we have created a single ZIP file which has everything you need.

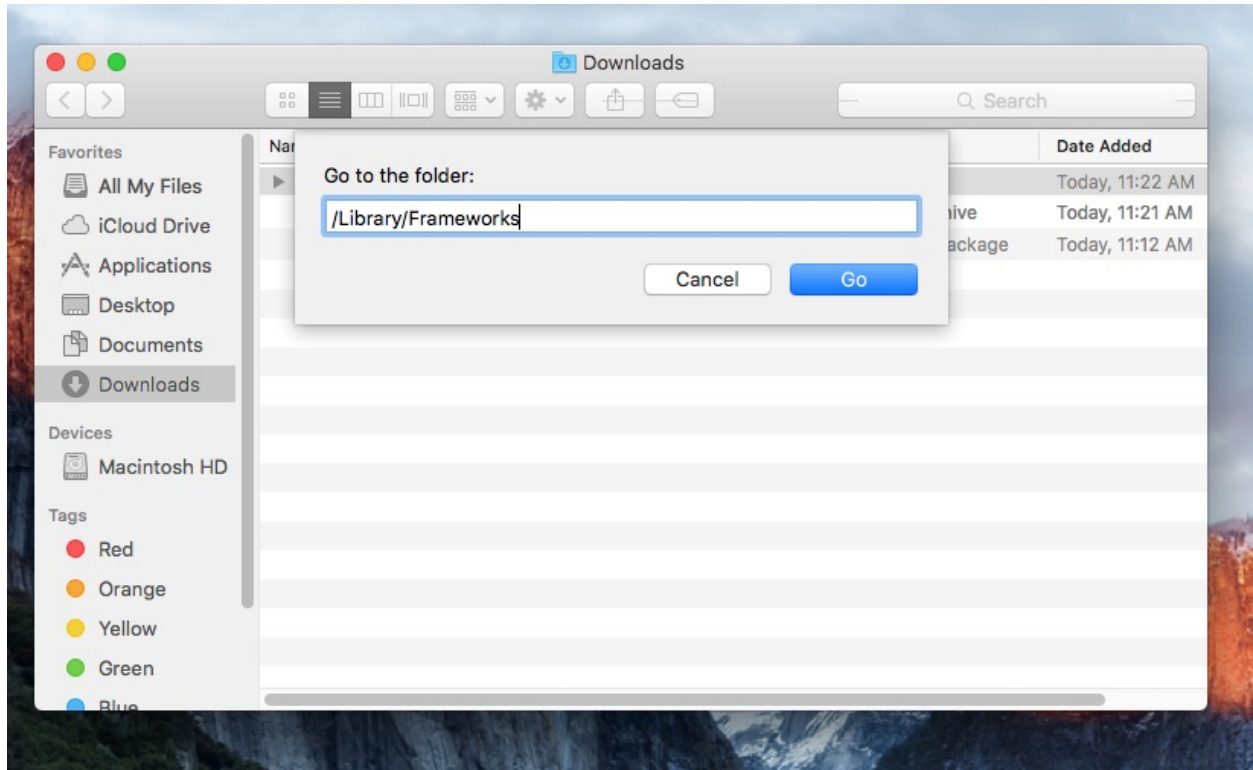
Download the zip of the multimedia frameworks [here](#). (Thanks to MPF developer Jan Kantert for hosting it!) The zipped download is 170 MB, and the unzipped size is 529 MB.

Unzip it, and copy (or drag and drop) the five things in the zip file's Frameworks folder to your own Mac's `/Library/Frameworks` folder.

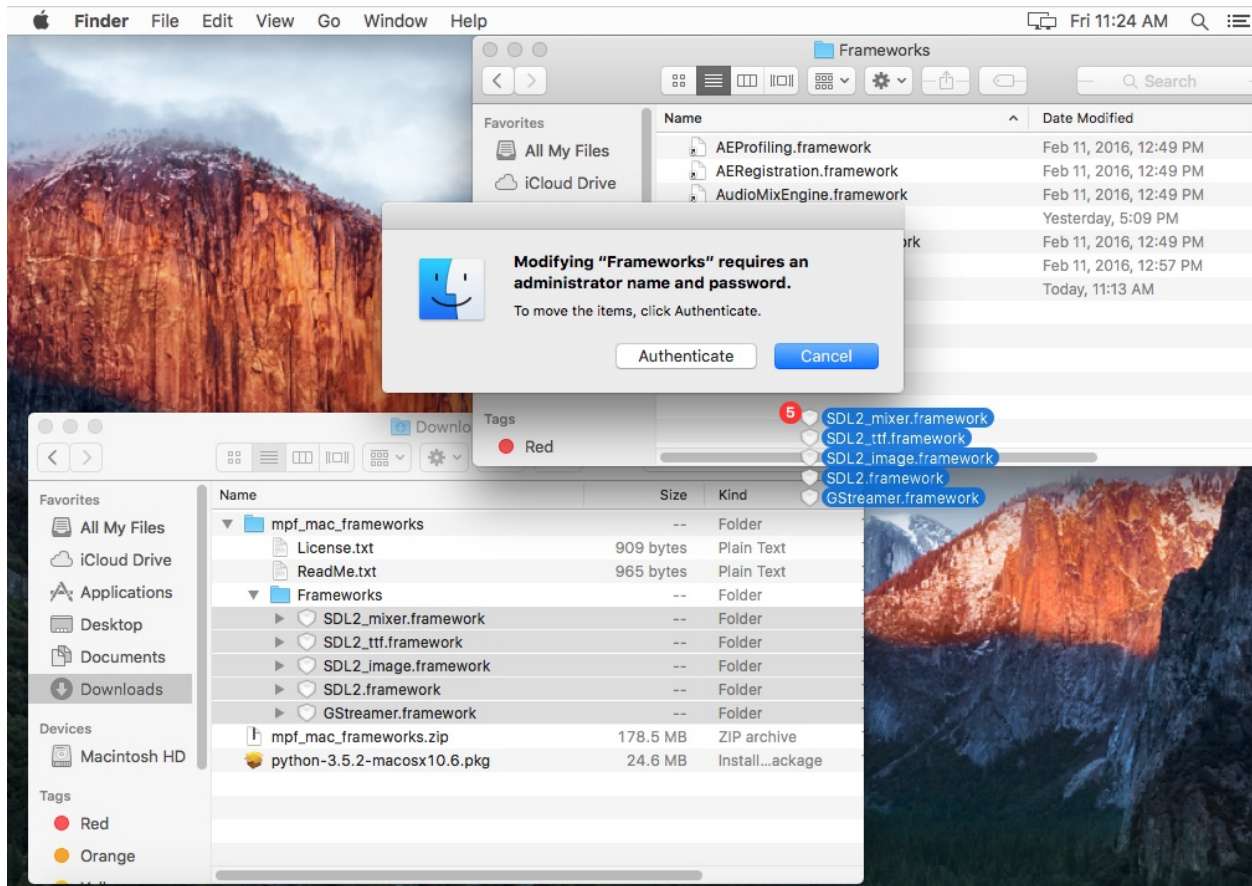
Depending on your Mac's settings, you might not see the `/Library/Frameworks` folder in Finder. If this is the case, use the `Go -> Go to Folder...` menu, and then type `/Library/Frameworks` and hit enter.

The following three images illustrate the steps:

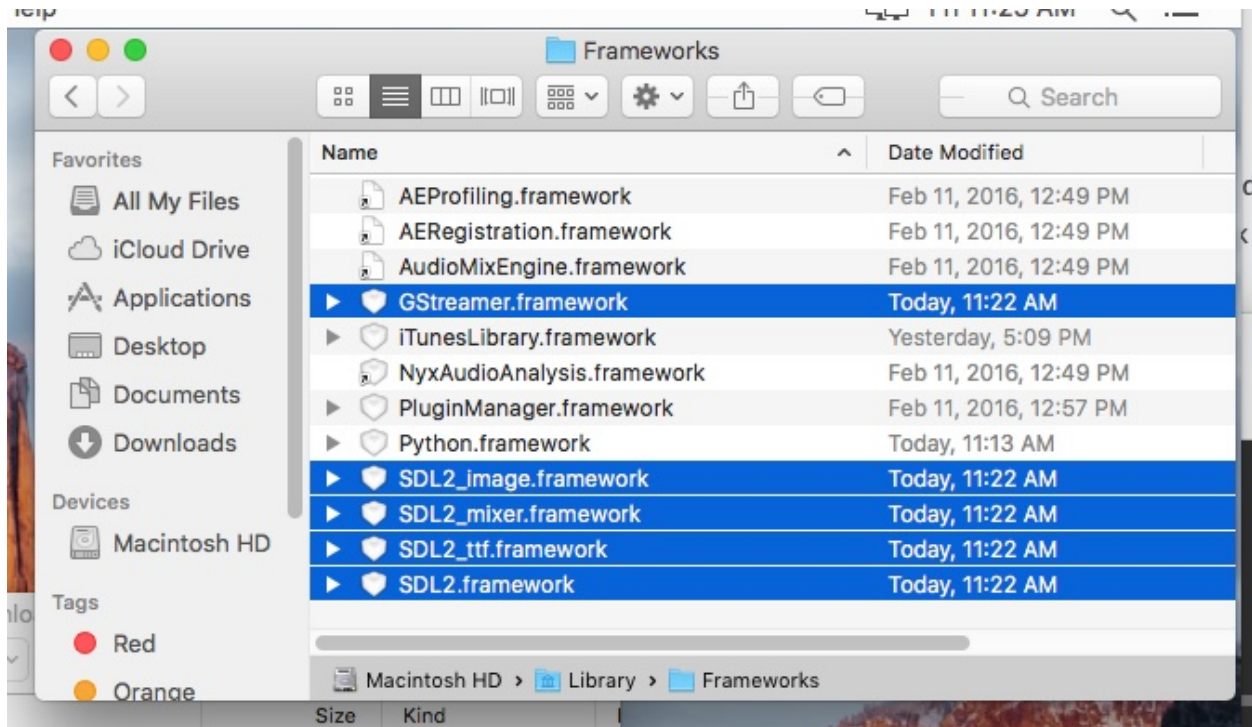




Note that you will need to authenticate (which just means you have to enter your password) in order to be able to copy those frameworks into your Mac's frameworks folder. The authentication message will automatically pop up when you drag and drop the files:



When you're done, your Mac's /Library/Frameworks folder should have the five new frameworks (plus whatever random ones you already had), which should look something like this:

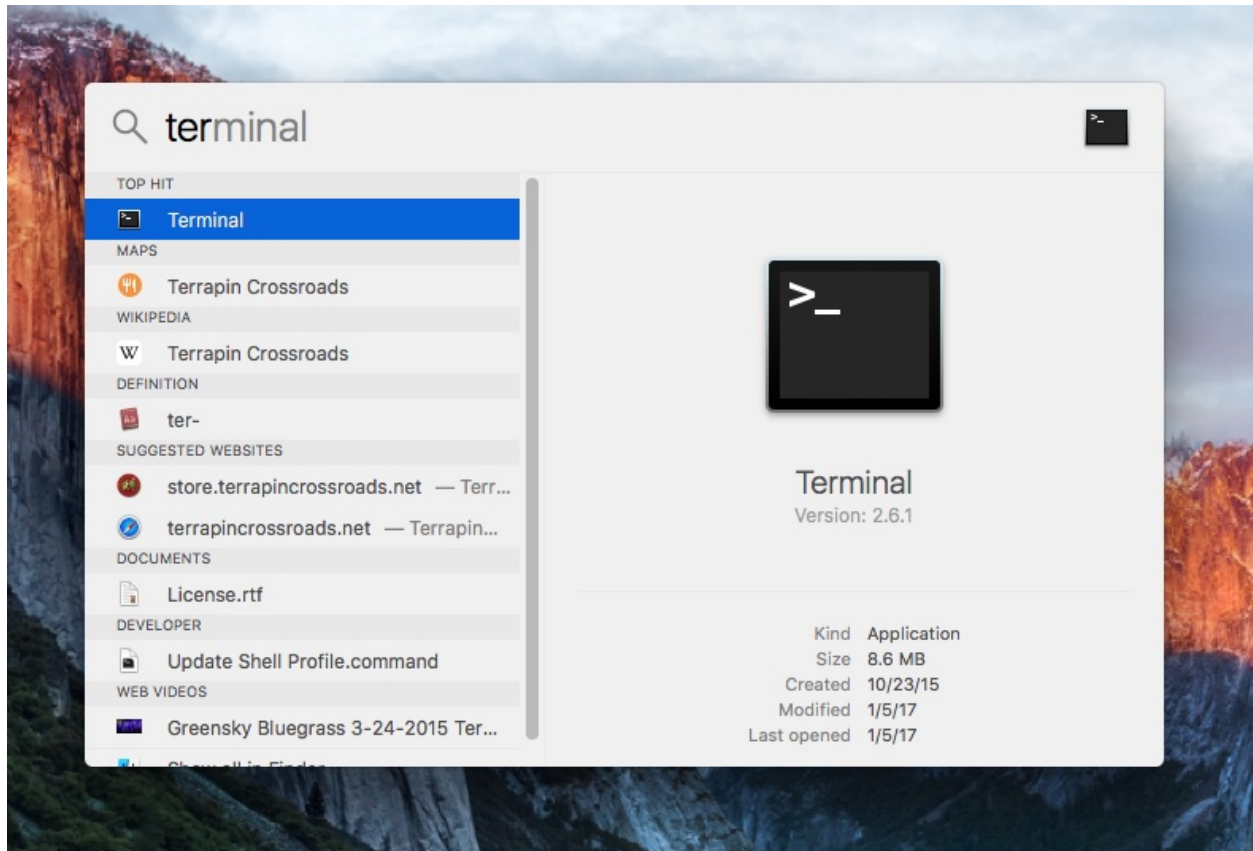


2. Install the Mac developer tools

Next you have to install something called the “Command Line Developer Tools” which is a package of software development tools created by Apple which MPF relies on to get installed.

To do this, you need to use the “Terminal” app (which is essentially a command prompt window for the Mac).

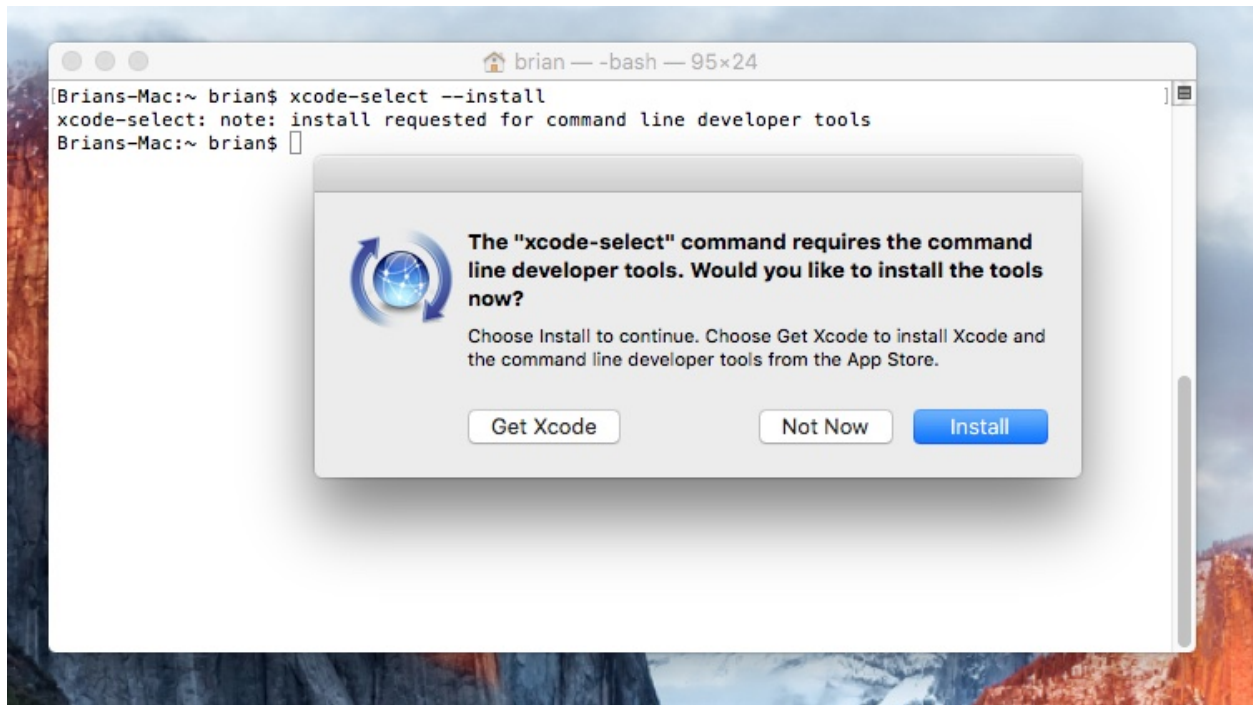
The easiest way to launch the Terminal app is to use Spotlight (press the CMD + Spacebar) and then just type “Terminal”, like this:



Next, type the following command into the prompt in the terminal and press Enter:

```
xcode-select --install
```

That should pop up a box which gives you the option to install the command line tools, like this:



Click the “Install” button here to get just the command line tools. The “Get XCode” button installs more than you need.

The download will be about 150 MB, and the total install will be about 1.1 GB.

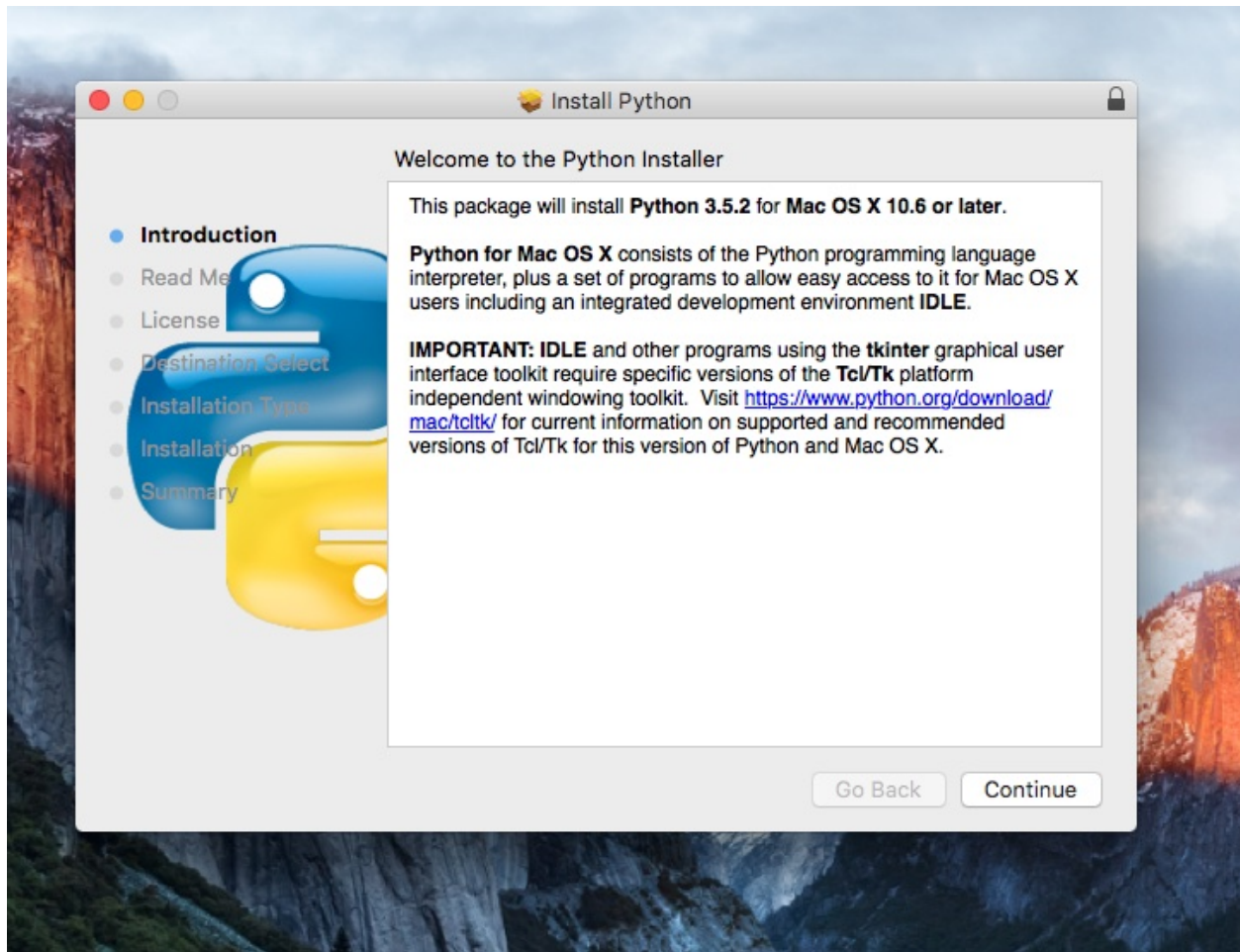
If you already have the command line tools installed, that’s fine. You’ll get some kind of error saying they’re already installed and you can move on.

3. Install Python 3.5 (not Python 3.6)

MPF is written in a computer language called “Python”. This means you have to install Python first before you can use MPF. Luckily this is just a one-time install, and you don’t have to install it again if you update MPF later.

On Mac platforms, MPF requires Python 3.4 or 3.5. (There is a Python 3.6, but that’s untested with MPF.) So we recommend that you install Python 3.5.

You can download Python 3.5 directly via [this link](#). (Note that the final digit in the Python version number is the “patch” number, so 3.5.2 is the latest version of Python 3.5.)



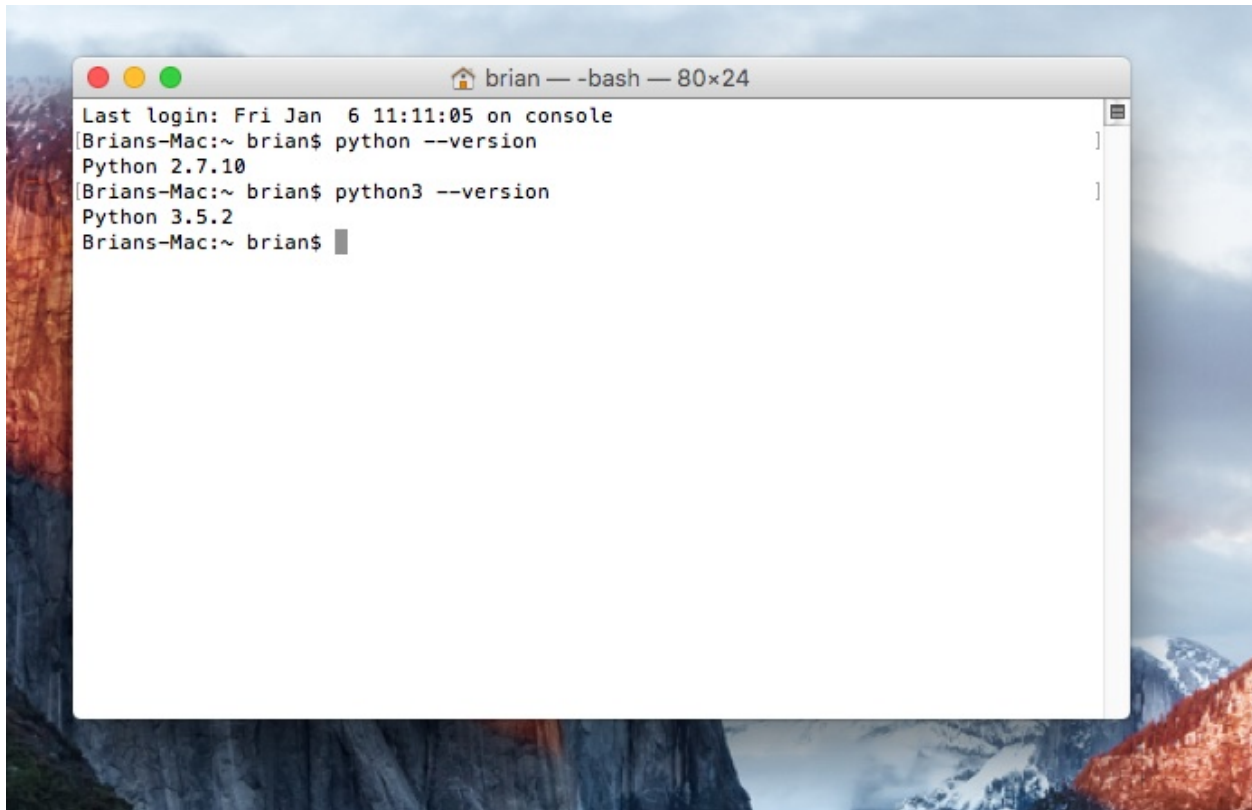
Installing Python is pretty straightforward. It's a standard Mac installation package. You can click next, next, next, agree to the license, enter your password, and you're all set.

Note: Macs have an older version of Python built in, but it's Python 2.x, and MPF requires Python 3, so that's why you have to install Python now. The new Python 3 that you install here will happily live alongside the Python 2.x that your Mac already has.

You can check to make sure Python 3.5 installed correctly from the Terminal window. To do that, run the command:

```
python3 --version
```

You should see it print something like "Python 3.5.2". Note that you have to run the command "Python3", not "Python", since the regular python command without the "3" on the end points to the Python 2.x that's built into your Mac. Here's a screenshot showing running "python" and "python3" and the different between the two:



4. Install/upgrade some Python components

Python includes a utility called “pip” which is the name of the Python Package Manager. Pip is used to install Python packages and applications from the web. (It’s kind of like an app store for Python apps.)

So the next step is to use pip to install/upgrade some components that we’ll need to install MPF. (This command will actually update pip itself too.)

Note that the command you run is “pip3”, not “pip”, since again we need to point to the pip that’s associated with the Python 3.5 installation, not the built-in 2.x version.

So next run the following command:

```
pip3 install pip setuptools cython==0.24.1 --upgrade
```

This command will download and install the latest versions of the *pip* and *setuptools* packages, as well as version 0.24.1 of a package called *cython*. The results will look something like this (though the exact version numbers might be different depending on what’s the latest whenever you’re running this):

```
Collecting pip
  Downloading pip-9.0.1-py2.py3-none-any.whl (1.3MB)
    100% |#####| 1.3MB 2.5MB/s
Collecting setuptools
  Downloading setuptools-32.3.1-py2.py3-none-any.whl (479kB)
    100% |#####| 481kB 4.3MB/s
Collecting cython==0.24.1
  Downloading Cython-0.24.1-cp35-cp35m-macosx_10_6_intel.macosx_10_9_intel.macosx_10_9_x86_64.macosx_10_10_intel.macosx_10_10_x86_64.whl (3.8MB)
```



```

100% |#####| 3.8MB 7.6MB/s
Installing collected packages: pip, setuptools, cython
Successfully installed cython-0.24.1 pip-9.0.1 setuptools-32.3.1

```

5. Install MPF

Next you can run pip again to install MPF itself. Technically what you're installing is "mpf-mc", which is the [Mission Pinball Framework Media Controller](#) package, but that package will also install the MPF game engine. Install MPF like this:

```
pip3 install mpf-mc
```

Your results should look something like the results below. The MPF install will download and install several other packages which are all these other things are.

Note: The "kivy" component will take awhile to install. Maybe a minute or two where it looks like it's not doing anything, but it's fine.

```

Brians-Mac:~ brian$ pip3 install mpf-mc
Collecting mpf-mc
  Downloading mpf-mc-0.32.12.tar.gz (11.1MB)
    100% |#####| 11.1MB 29.6MB/s
Collecting ruamel.yaml<0.11,>=0.10 (from mpf-mc)
  Downloading ruamel.yaml-0.10.23.tar.gz (228kB)
    100% |#####| 235kB 9.0MB/s
Collecting mpf>=0.32.6 (from mpf-mc)
  Downloading mpf-0.32.6.tar.gz (556kB)
    100% |#####| 563kB 18.0MB/s
Collecting kivy>=1.9.1 (from mpf-mc)
  Downloading kivy-1.9.1.tar.gz (16.4MB)
    100% |#####| 16.4MB 7.4MB/s
Collecting ruamel.base>=1.0.0 (from ruamel.yaml<0.11,>=0.10->mpf-mc)
  Downloading ruamel.base-1.0.0-py3-none-any.whl
Collecting pyserial>=3.2.0 (from mpf>=0.32.6->mpf-mc)
  Downloading pyserial-3.2.1-py2.py3-none-any.whl (189kB)
    100% |#####| 194kB 4.1MB/s
Collecting pyserial-asyncio>=0.2 (from mpf>=0.32.6->mpf-mc)
  Downloading pyserial_asyncio-0.3-py3-none-any.whl
Collecting Kivy-Garden>=0.1.4 (from kivy>=1.9.1->mpf-mc)
  Downloading kivy-garden-0.1.4.tar.gz
Collecting requests (from Kivy-Garden>=0.1.4->kivy>=1.9.1->mpf-mc)
  Downloading requests-2.12.4-py2.py3-none-any.whl (576kB)
    100% |#####| 583kB 4.8MB/s
Installing collected packages: ruamel.base, ruamel.yaml, pyserial, pyserial-asyncio, mpf, requests,
↳ Kivy-Garden, kivy, mpf-mc
  Running setup.py install for ruamel.yaml ... done
  Running setup.py install for mpf ... done
  Running setup.py install for Kivy-Garden ... done
  Running setup.py install for kivy ... done
  Running setup.py install for mpf-mc ... done
Successfully installed Kivy-Garden-0.1.4 kivy-1.9.1 mpf-0.32.6 mpf-mc-0.32.12 pyserial-3.2.1 pyserial-
↳ asyncio-0.3 requests-2.12.4 ruamel.base-1.0.0 ruamel.yaml-0.10.23

```



```
Brians-Mac:~ brian$
```

If you want to make sure that MPF was installed, quit the Terminal app and restart it, and then run:

```
mpf --version
```

This command can be run from anywhere and should produce output something like this:

```
Brians-Mac:~ brian$ mpf --version  
MPF v0.33.12
```

(Note that the actual version number of your MPF installation will be whatever version is the latest.)

6. Download & run the “Demo Man” example game

Now that you have MPF installed, you probably want to see it in action. The easiest way to do that is to download a bundle of MPF examples and run our “Demo Man” example game. To do that, follow the instructions in the [How to run “Demo Man”, an MPF example game](#) guide.

There’s another example project you can also check out if you want called the “MC Demo” (for media controller demo) that lets you step through a bunch of example display things (slides, widgets, sounds, videos, etc). Instructions for running the MC Demo are [here](#).

7. Install whatever drivers your hardware controller needs

If you’re using MPF with a physical machine, then there will be some specific steps you’ll need to take to get the drivers installed and configured for whatever control system you’ve chosen. See the [control systems](#) documentation for details. (You don’t have to worry about that now if you just want to play with MPF first.)

Running MPF

See the section [How to start MPF and run your game](#) for details and command-line options.

Keeping MPF up-to-date

Since MPF is a work-in-progress, you can use the *pip* command to update your MPF installation.

To to this, run the following:

```
pip3 install mpf mpf-mc --upgrade
```

This will cause *pip* to contact PyPI to see if there’s a newer version of the MPF MC (and any of its requirements, like MPF). If newer versions are found, it will download and install them.

Next steps!

Now that MPF is installed, you can follow our [step-by-step tutorial](#) which will show you how to start building your own game in MPF!

Installing MPF on Linux

As part of our automated build process, we build and test MPF and MPF-MC against Ubuntu 14.04 & 16.04 and Debian jessie.

Download the MPF Debian Installer (which is used for all of these) from <https://github.com/missionpinball/mpf-debian-installer/archive/dev.zip>

Unzip it, and from a terminal run `chmod +x install && sudo ./install` from the folder you unzipped the files to. If you are using a P-Roc or P3-Roc also run `chmod +x install-proc && ./install-proc` (skip for other platforms). Consult the README for more information.

Download & run the “Demo Man” example game

Now that you have MPF installed, you probably want to see it in action. The easiest way to do that is to download a bundle of MPF examples and run our “Demo Man” example game. To do that, follow the instructions in the [How to run “Demo Man”, an MPF example game](#) guide.

There’s another example project you can also check out if you want called the “MC Demo” (for media controller demo) that lets you step through a bunch of example display things (slides, widgets, sounds, videos, etc). Instructions for running the MC Demo are [here](#).

Running MPF

See the [How to start MPF and run your game](#) for details and command-line options.

Keeping MPF up-to-date

To upgrade MPF just re-run the installer which will make sure that you will also get updated dependencies:

```
sudo ./install
```

Alternatively, since MPF is a work-in-progress, you can use the `pip` command to update your MPF installation.

To to this, run the following:

```
pip3 install mpf mpf-mc --upgrade
```

This will cause `pip` to contact PyPI to see if there’s a newer version of the MPF MC (and any of its requirements, like MPF). If newer versions are found, it will download and install them.

To install the latest dev release (not generally recommended) which allows you to try bleeding-edge features run:

```
pip3 install mpf mpf-mc --pre --upgrade
```

To downgrade (or install a specific release x.yy.z) run:

```
pip3 install mpf=x.yy.z
pip3 install mpf-mc=x.yy.z
```


Installing MPF on Xubuntu

Xubuntu is a Ubuntu-based linux distribution using the minimalist, yet still feature-packed, XFCE desktop manager. The focus of this guide will be for getting MPF up and running directly from power (unattended) for use in a production scenario.

1. Create Xubuntu Installation Media

You will need:

- 4GB USB Flash Drive or larger
- Latest ISO from <https://xubuntu.org/getxubuntu/>

Write the ISO on Windows

Use [Universal USB Installer](#)

Write the ISO on MAC

For Mac, you can use the built-in command line tools.

- Identify the correct device: `diskutil list`
- **Unmount the device:** `sudo diskutil unmountDisk /dev/disk[num]`
 - num is determined by the number of devices mounted
 - Actual device name will be something like `/dev/disk2` or `/dev/disk3`
- **Write the ISO with raw write(rdisk):** `sudo dd bs=1m if=/path/to/xubuntu-16.04.iso of=/dev/rdisk[]`
 - Speed is MUCH faster when specifying with `/dev/rdisk[num]` vs `/dev/disk[num]`
 - Actual dd command will be something like `sudo dd bs=1m if=/path/to/xubuntu-16.04.iso of=/dev/rdisk3`

You should be able to use dd on Linux as well.

2. Install Xubuntu

Boot from the installation media (you may need to change something in your BIOS to enable booting from USB). It should be a fairly straight-forward linux installation. When it asks about partitioning, choose the “Guided - entire hard disk” option (unless you have a specific reason not to). You will be asked to create a user account. When doing so, it’s important that you: **DO NOT ELECT TO ENCRYPT THE HOME FOLDER**. If you encrypt the home folder, the auto login will not work and will have to reinstall to fix.

3. Configure Xubuntu

The system will reboot after installation. Login with your username and password then follow these steps:

- Launch a Terminal emulator
- Update the sources: `sudo apt-get update`
- Upgrade all the things: `sudo apt-get upgrade`
- **Setup auto-login to the XFCE desktop**
 - Create the file `/etc/lightdm/lightdm.conf.d/12-autologin.conf` and edit it to contain:

```
[Seat:*]
autologin-user=your_username
autologin-user-timeout=0
```

- Be sure to change `your_username` to the username you created during installation.
- **Optional: Reduce the Network Timeout**
 - You should do this if the system will not always be connected to the internet
 - Edit the file `/etc/systemd/system/network-online.target.wants/networking.service`
 - Find the line `TimeoutStartSec=5min` and change to `TimeoutStartSec=10sec`

4. Install MPF

The existing Debian install script works perfectly on Ubuntu. The following commands will install the current versions of MPF and MPF-MC as well as each of their dependencies.

```
cd ~
wget https://github.com/missionpinball/mpf-debian-installer/archive/dev.zip
unzip dev.zip
cd mpf-debian-installer-dev
sudo -H ./install
rm ~/dev.zip && rm -Rf ~/mpf-debian-installer-dev
```

If you want to make sure that MPF was installed, you can run:

```
mpf --version
```

This command can be run from anywhere and should produce output something like this:

```
username@host:~$ mpf --version
MPF v0.33.13
```

(Note that the actual version number of your MPF installation will be whatever version is the latest.)

5. Setup your Machine Config

- Copy your machine config root folder to `~/` which is the same as `/home/your_username/`.
- **Create a new file named `run.sh` in `/home/your_username/your_machine_folder/`**

- Edit the file to contain:

```
#!/bin/bash
xterm -e "cd /home/your_username/your_machine_folder && mpf both -c config"
```

- Change your_username to the username you created during installation.
- Change your_machine_folder to the name of your specific machine folder.
- Change config part to reflect the name of your top-level config file in ~/your_machine_folder/config/.

6. Setup your Machine Config to Auto-execute

When XFCE is executed, it runs all the *Desktop Entries* found within ~/.config/autostart. We'll create one of our own to run the script we just added to our machine config.

- Create the file ~/.config/autostart/mpf.desktop and edit it to contain:

```
[Desktop Entry]
Version=1.0
Name=MPF
Comment=Mission Pinball
Exec=/home/your_username/your_machine_folder/run.sh
Path=/home/your_username/your_machine_folder/
Terminal=false
Type=Application
```

- Change your_username to the username you created during installation.
- Change your_machine_folder to the name of your specific machine folder.

That's it. At this point, you should be able to reboot and watch the system auto-login to XFCE and then launch MPF using the script we added to your machine config.

Other Considerations

If using the SmartMatrix RGB DMD with this setup, you need to add the system user running your game to the dialout group.

```
sudo usermod -a -G dialout your_username
```

Installing MPF on a Raspberry Pi 3

Warning: Raspberry Pi support is experimental at this point. Users have found various issues with audio, and we're not sure whether the RPi has enough power to support MPF. So this document is more like a collection of notes versus a solid guide. We welcome your feedback or experience with other low-cost systems, though at this point if you're looking for a development platform, we'd probably recommend buying a more beefy x86 computer. For a "final" machine an inexpensive (<\$200) Intel-based system running Linux or Windows might be better suited. However, it should be possible to run your final game on a RPi3 if you tune your game accordingly.

For example, this would include transcoding your videos to a format which can be played hardware accelerated on the RPi.

One first word: Don't try to install mpf on a Raspberry Pi B+ or Raspberry zero, it just won't work or will be very slow. Get yourself at a Raspberry Pi 3, they have a quad-core processor running with more than 900MHz. RPi3 also has better audio than RPi 1 (still not perfect). An HDMI audio adapter may be worthy for better audio.

One nice thing we will have afterwards is a low-cost PC which will run fast enough for mpf-mc with audio, video, antialiasing and touchscreen support.

Let's start:

- get the latest Kivypie version (a minimal version without X-Server but preinstalled kivy) here: <http://kivypie.mitako.eu/kivy-download.html> Many Kudos to Albert Casals and their group, since normally its a pain to install kivy on a raspberry (compiling lasts forever).
- Unzip the image (do not copy .zip file to your SD card).
- depending on your development os use Win32 Diskimager, dd, Imagemwriter. . . to write your image to the sd-card (use at least an 8 GB Card). You can find Instructions here: <https://www.raspberrypi.org/documentation/installation/installing-images/>
- insert the sd-card into your pi and boot it up (first boot does take some time since it sets some os specific parameters)
- login with user:sysop password:posys
- now type this:

```
sudo raspi-config
```

and choose 7. Advanced Options -> A1. Expand Filesystem to use the whole SD-Card Space, we will need it. You can change your username and localization settings too.

After that we will give the GPU a bit more of RAM:

Go to 7. Advanced Options -> A3 Memory split and change the value to 256.

Now reboot, login and type:

```
sudo apt-get update
```

to update the debian repositories links.

The standard /tmp "folder" is too small on pipaos, just type:

```
sudo umount /tmp
```

to get rid of it. (It will be created automatically if needed and will have the whole space afterwards)

Now run the *MPF Linux Debian installer*. It will install MPF, MPF-MC and all dependencies for you.

This will take some time as it may compile some drivers mpf-mc needs like the audio driver. Sometimes it looks like it hangs, but it does not. It will take up to half an hour, at least on a Raspberry 1 (which you should not use). Compiling is really slow on the Raspi.

Now copy your machine folder from your develop station or create a new one under your home directory (/home/sysop/your_machine)

If you need a file-manager start mc (No, not the mpf mediacontroller, its the midnight commander ;-))

If you need to copy your folders from an usb-stick you have to manually mount it (we dont have X, so everything has to be done by hand).

```
sudo mount /dev/sda1 /mnt
```

This works in 90% otherwise your stick is not sda1, just look inside the /dev folder to find out which device you have to mount or type

```
lsblk
```

to list your block devices.

Now you find the contents of your stick in /mnt.

To tell mpf-mc and the underlying kivy to use the framebuffer via SDL2 you have to put this in your machine/config/config.yaml:

```
window:
  width: 1280
  height: 800

kivy_config:
  graphics:
    fbo: force-hardware
```

More or less important last steps:

Serial communication:

Linux always had and has the possibility to log in via a serial connection. Since all of the pinball hardware I'm aware of uses serial communication with mpf leaving this feature running is not good at all, since you will get noise from your kernel. The device is called /dev/ttyAMA0 and you need to stop it from starting:

Type:

```
sudo systemctl disable serial-getty@ttyAMA0.service
```

Now you have to disable the console itself:

```
sudo mc
```

to start Midnight Commander as root (normally you should not do this, but this time you have to.)

Now go to /boot and press F4 over cmdline.txt.

Remove these entries:

```
console=ttyAMA0,115200 kgdboc=ttyAMA0, 115200
```

and save the file.

You have the possibility to connect RS 232 devices directly to the raspi but take care, the voltage levels are 3.3V on the raspi gpio. Further instructions here: http://elinux.org/RPi_Serial_Connection

Sound output:

Navigate to /boot/config.txt if you want to use audio out of the Raspberry built in “soundcard”: edit this file as root and insert this line:

```
dtoverlay=audio=on
```

Inside this file you can change some settings that initialize on boot, its like a bios which the raspberry does not have.

Video Playback:

If you need video capability in your mpf-mc you need to install one player that kivy will use to play your videos:

```
sudo apt-get install omxplayer
```

You can try videoplayback with

```
omxplayer your_video.mp4
```

To test the video playback capability under kivy into the framebuffer just run this command:

```
python3 -m kivy.uix.videoplayer /usr/local/lib/python3.4/dist-packages/mpfmc/tests/machine_files/video/  
↪videos/mpf_video_small_test.mp4
```

Troubleshooting:

No sound:

If you have trouble getting sound out of your speakers or monitor have a look here:

<https://www.raspberrypi.org/documentation/configuration/audio-config.md>

Do a reboot:

```
sudo reboot
```

OPP Hardware not found:

If you are using OPP Hardware you have to blacklist the Cypress Thermometer: in /etc/modprobe.d/blacklist.conf add:

```
blacklist cytherm
```

If blacklist.conf does not exist, just create a new empty file as root. The USB Enumerator thinks a Thermometer is plugged in but it is definitely not ;-)

Remote log in:

To log in from your development machine into your raspberry you can do it easily via ssh. For windows I recommend putty: <http://www.putty.org/>

See whats going on on your pinball:

```
sudo dispman_vncserver
```

This starts a vncserver on your raspi and you can log in remotely from a RealVNCViewer <https://www.realvnc.com/download/viewer/>

Kivypie IP address, port 5900. It is not 100% reliable but fairly usable. Thanks to Peter Hanzel.

Start mpf and mpf-mc

To test your installation type

```
mpf
```

in your machine_folder.

Press (STRG+ALT F2) to change to the second terminal tty2.

Login and start mpf-mc inside your machine folder with

```
mpf mc
```

Enjoy!

Installing MPF on a Pine64 with Ubuntu

Note: This procedure for installing MPF on a Pine64 does not fully work. (MPF runs fine, Kivy installs fine, but MPF-MC does not run.) If you want to use MPF on a Pine64, maybe you can help figure out why this doesn't work and share your findings with us?)

Hardware Notes

- Spring for the fastest MicroSD card you can (Samsung Evo cards are reportedly the fastest), at least 16GB.
- The Pine64's video seems to only support 1080p and 4K resolutions, so make sure your display can do one or both of those at a proper 16:9 aspect ratio or else everything will be scaled and squished and it looks awful.
- If you find that your pine64 does not boot it maybe due to using a HDMI->DVI cable, try HDMI to HDMI first.

System Notes

There are a bunch of things that arrive broken with the current Ubuntu installer for Pine64 (as of this writing in November 2016). Some of them will prevent MPF from installing, and a few are just annoying.

Instructions

After installing the OS following the instructions on the [Pine64 Wiki](#), expanding the volume to the full size of the SD card, and getting connected to the Internet, follow these steps. Don't try to update the installed system before following this.

Locale

Locale arrives broken and this wrecks all kinds of havoc, so here's how to fix it.

Assuming you want US English, substitute your preferred language if not:

```
$ sudo locale-gen "en_US.UTF-8"
Generating locales...
  en_US.UTF-8... done
Generation complete.

$ sudo dpkg-reconfigure locales
Generating locales...
  en_US.UTF-8... up-to-date
Generation complete.
```

That command will open a text-based dialog, we recommend that you don't choose "ALL" and only select the one or a few languages you want (generating them all takes a long time). Then reboot, then do the above reconfigure step AGAIN, then reboot, then run:

```
$ locale
```

And make sure it looks good. Mine says:

```
LANG=en_US.UTF-8
LANGUAGE=en
LC_CTYPE="en_US.UTF-8"
LC_NUMERIC=en_US.UTF-8
LC_TIME=en_US.UTF-8
LC_COLLATE="en_US.UTF-8"
LC_MONETARY=en_US.UTF-8
LC_MESSAGES="en_US.UTF-8"
LC_PAPER=en_US.UTF-8
LC_NAME=en_US.UTF-8
LC_ADDRESS=en_US.UTF-8
LC_TELEPHONE=en_US.UTF-8
LC_MEASUREMENT=en_US.UTF-8
LC_IDENTIFICATION=en_US.UTF-8
LC_ALL=
```

It took a few tries for this to stick for me, so do it again, including reboot, if your results here are wrong.

Fix the Software Boutique

This arrives broken, too. Oddly, running the Mate Welcome as root and clicking a button partly fixes it.

```
$ sudo ubuntu-mate-welcome
```

When it comes up, click on the “Subscribe to updates” button, then quit it.

Now go to System -> Administration -> Software Boutique. Click on the wrench, then do each repair option (after clicking one, wait for it to say it has finished).

Now go to System -> Administration -> Software Updater and get everything up to date. You will need to reboot again after that.

Install Missing pip3

```
$ apt-get install python3-pip
```

The path where pip puts executables is not in the system default path, so edit ~/.bashrc to add the following path:

```
$ sudo nano ~/.bashrc
```

At the bottom of the file add the following:

```
export PATH=~/.local/bin:$PATH
```

Hit “control + x” to save and “y” then “return” to save the file as the same name.

Now start a fresh terminal so that this new PATH is included in your current environment. Then:

Install MPF

Download the MPF Debian Installer from

<https://github.com/missionpinball/mpf-debian-installer/archive/v0.30.zip>

(This is for MPF versions 0.30 and newer)

To unzip the file navigate in your terminal to the location of the downloaded files.

Unzip the file:

```
$ unzip v0.30.zip .
```

If this does not run you may need to install unzip:

```
$ sudo apt-get install unzip
```

After unzip, run ./mpf-debian-installer-0.30/install from the folder you unzipped the files to. Consult the README for more information.

```
$ pip3 install mpf-mc
```


Running MPF

See the *How to start MPF and run your game* page for details and command-line options.

Note: These guides just show you how to get MPF up and running. If you're using MPF with a physical machine, check out the *MPF compatible control systems / hardware* guide for details about how to get the drivers and configuration set for the specific hardware controller platform you've chosen.

Installing the MPF Monitor

We have a rough prototype of a graphical tool called the “MPF Monitor” which you can use to connect to a running instance of MPF to graphically interact with switches, lights, and LEDs, and to see the status of various devices. You can even add a picture of your playfield and drag-and-drop the MPF mechanisms onto it which makes it possible to “play” your machine via a simulation.

Details in the MPF Monitor are [here](#).

Migrating from previous versions of MPF

Migrating from older versions of MPF

Upgrading MPF to the latest version

This is covered in the relevant install sections:

- Linux: [linux.html#keeping-mpf-up-to-date](#)
- Windows: [windows.html#keeping-mpf-up-to-date](#)
- Mac: [mac.html#keeping-mpf-up-to-date](#)

If you are upgrading from 0.21 (or earlier) you need to install Python 3 (as explained in the installation section for your platform).

Migrate your config

A migrator exists for config version 3 (0.21 and earlier) to 4 (0.30 to 0.33). There will be a migrator for version 4 to 5 (version 0.50) when 0.50 is released. If you encounter any problems during migration feel free to ask in the forum.

How to start MPF and run your game

MPF is a console-based application which you run from the command line.

The quick version

1. Open a command prompt
2. Switch to your machine folder
3. Run `mpf both`

Starting the MPF game engine and media controller together

You can start both the MPF game engine and the *media controller* at the same time with a single command.

Since this is done from the command line, you'll need to open a command line window. On Windows, you can right-click on the Start Button (or whatever it's called these days) and click the "Command Prompt". On Mac OS X you can run the Terminal app. On Linux, well, if you're using Linux, you know what a command line is. :)

From the command line, change to the directory which is the root of your machine folder. This is the folder that contains your machine's config, modes, shows, etc. folders.

Note: Prior to MPF 0.30, we recommended that you put your machine's folder in the `/machine_files` folder inside the MPF package. That is changed now, and you can put your machine folder(s) wherever you want. In fact now that MPF has a "real" installer, the MPF package folder is hidden deep inside your system.

Then run:


```
mpf both <enter>
```

The `mpf both` command is what we use and probably what you'll use 99% of the time.

Starting the MPF media controller

Alternately you can choose to run just the media controller by itself (still from within your machine folder) like this:

```
mpf mc <enter>
```

You should see a popup window and a bunch of stuff scroll by in the console.

Starting the MPF game engine

You can run the MPF game engine by itself by running:

```
mpf game <enter>
```

Note that if you do not have a media controller running, the game engine won't start fully because it will get stuck trying to connect to the media controller. To avoid this if you just want to run the game engine by itself, add the `-b` command line option. (Details below)

Specifying command-line options

There are several command-like options you can use when you run MPF. To use them, add them *after* the name of the MPF command you're running, like:

```
mpf game -x -v  
mpf mc -xvV  
mpf both -v -b
```

The full list of available commands is covered in the documentation for each command (discussed below).

Understanding how this works

When you install MPF, the command `mpf` is registered with your system. Then you can open a command prompt and run "`mpf`" from any folder.

There are several sub-commands you can specify when you run MPF. You specify a sub-command by running `mpf <command>`. (Some `mpf` commands take additional options).

Here's a list of valid MPF commands. Click on any one of them for full details and command-line options.

- *mpf* (Starts the MPF game engine and other commands)
- *mpf game* (Starts the MPF game engine)
- *mpf mc* (Starts the MPF Media Controller)
- *mpf both* (Starts both the MPF game engine and media controller at the same time)
- *mpf migrate* (Migrates older config and show files to the current version)

Specifying BCP ports

By default, the MPF game engine and the MC will connect via TCP port 5050. *You can change that port to whatever you want though.*

MPF command-line utility

When you install MPF, it registers an executable called `mpf` and puts it in your system path. Everything you do with MPF will use this tool from the command line.

Simply running `mpf` by itself will start the MPF game engine and run whatever machine configuration is in the current folder. But you can also use `mpf` to launch other things, like `mpf mc` to start the media controller, or `mpf migrate` to migrate your config files to the current version of MPF.

A full list of all the available commands, along with the various command line options, is [here](#).

Command line options

`-version`

Prints the version of MPF and exits:

```
$ mpf --version
MPF v0.30.0
```

`<command>`

Runs the MPF command (with or without additional options).

See the [MPF commands](#) documentation for options.

MPF commands

TODO

mpf both (command-line utility)

Starts both the MPF game engine and the MPF Media Controller from a single command window with a single command. This is effectively the same as running both `mpf game` and `mpf mc`, but more convenient.

When you run `mpf both`, the console log outputs from both MPF and MPF-MC will be mingled together in the console window. However the log files in your machine's `/logs` folder will still be separate.

Also note that you can pass command line options to both MPF and MPF-MC after the “both” command, like this:

```
mpf both -v  
  
mpf both -v -V -b
```

etc. See the [mpf game \(command-line utility\)](#) and [mpf mc \(command-line utility\)](#) command references for a full list of command line options.

To quit MPF and MPF-MC, either click in the graphical pop up window (so it has focus) and hit Esc, or click in the console window and press CTRL+C.

Note: If you use the `-l` (lowercase L) option to specify a log file along with `mpf both`, you need to use `-l` to specify the MPF log and `-L` to specify the MC log.

mpf core (command-line utility)

Runs the MPF “core” modules without any game logic. This feature has not been fully implemented yet, but it’s being put in place to facilitate using the MPF platform interface to be completely controlled by external sources such as PinMAME without any of MPF’s game logic.

mpf diagnosis (command-line utility)

Prints the current installed versions of MPF and the MPF-MC.

mpf game (command-line utility)

Starts the MPF game engine (the main MPF process).

Command line options

There are several command-line options you can use when running MPF. Note that single commands that take no options can be combined, so `mpf game -vVa` is the same as `mpf game -v -V -a`.

-a (lowercase)

Forces MPF to reload the config from the actual YAML config files, rather than from cache.

MPF contains a caching mechanism that caches YAML config files, and if the original files haven't changed since the last time MPF was run, it loads them from cache instead. Cached files are stored in your machine's temp folder which varies depending on your system.

-A (uppercase)

Do not cache the config files.

-b

Disables MPF's BCP interface, meaning MPF will not try to connect to a media controller via BCP. This is used if for some reason you just want to run MPF without MPF MC. Without this option, MPF will not start because it will just sit there trying to connect to the media controller.

-c (lowercase)

Specifies the name of the config file (or files) to load. Default config.yaml is used if this option is omitted. You do not have to specify the .yaml extension.

Examples:

Run MPF and load the config file config/config.yaml:

```
$ mpf game
```

Run MPF and load the config file config/nodisplay.yaml:

```
$ mpf game -c nodisplay
```

You can also chain multiple config files together by specifying a comma-separated list (no spaces). For example, to load config/config.yaml first, and then once that's loaded, merge in changes from config/fast.yaml, run:

```
$ mpf game -c config,fast
```

To load a machine folder from some other location, such as /home/brian/pinball/demo_man/config/config.yaml:

```
$ mpf game -c /home/brian/pinball/demo_man/config/config.yaml
```

-C (uppercase)

Specify the name of the MPF default config file which is loaded before your before your machine config. (MPF includes a file mpfconfig.yaml which is inside the MPF package which sets up default things like which modules are loaded, paths used, etc. If for some reason you want to override this file, you can do so with the -C option.

-h

Displays the command line help and exits. (Pretty much what's on this page.)

-f

New in version 0.32.

Forces MPF to load all assets at start (rather than the default behavior where some assets can be loaded only when modes start or based on other events). This is useful during development to ensure that all assets are valid and loadable.

-l (lowercase "l")

Specifies the name and path of the log file.

The default stores the log file in the /logs folder in your machine folder, with a file name of <year>-<month>-<day>-<hour>-<min>-<sec>-mpf-<hostname>.log.

Note that log files are standard log file formats that can be read and parsed with log file utilities. (The "Console" app is built-in to OS X, for example.)

-syslog_address

New in version 0.33.8.

Log to the specified syslog address. This can be a domain socket such as /dev/log on Linux or /var/run/syslog on Mac. Alternatively, you can specify host:port for remote logging over UDP.

-v (lowercase)

Enables verbose logging to the log file. Warning: Your log files will be huge, perhaps 1MB per minute of game time. Definitely only use this when you're troubleshooting.

-V (uppercase)

Enables verbose logging to the console output.

Note that due to the way the command prompt console works on Windows, enabling verbose logging on Windows will significantly affect MPF (in a bad way). Windows computers can run MPF no problem, but because of their weird console slowness we recommend that you do not use the -V command line option from a Windows computer.

-x (lowercase)

Ignores all platform: settings in your config files and forces MPF to run using the *virtual* platform interface. This is nice for testing when you don't have your physical hardware attached.

-X (uppercase)

Like -x, except it forces the *smart virtual* platform.

mpf mc (command-line utility)

Starts the MPF Media Controller.

Command line options

There are several command-line options you can use when running the MPF MC. Note that single commands that take no options can be combined, so `mpf mc -vVb` is the same as `mpf mc -v -V -b`.

-c (lowercase)

Specifies the name of the config file (or files) to load. Default `config.yaml` is used if this option is omitted. You do not have to specify the `.yaml` extension.

Examples:

Run MPF MC and load the config file `config/config.yaml`:

```
$ mpf mc
```

Run MPF and load the config file `config/nodisplay.yaml`:

```
$ mpf mc -c nodisplay
```

You can also chain multiple config files together by specifying a comma-separated list (no spaces). For example, to load `config/config.yaml` first, and then once that's loaded, merge in changes from `config/fast.yaml`, run:

```
$ mpf mc -c config,fast
```

To load a machine folder from some other location, such as `/home/brian/pinball/demo_man/config/config.yaml`:

```
$ mpf mc -c /home/brian/pinball/demo_man/config/config.yaml
```

-C (uppercase)

Specify the name of the MPF MC default config file which is loaded before your before your machine config. (MPF MC includes a file `mcconfig.yaml` which is inside the MPF MC package which sets up default things like which modules are loaded, paths used, etc. If for some reason you want to override this file, you can do so with the -C option.

Note that the -C option is used by both `mpf game` and `mpf mc`, but these two packages use different default files. So if you want to override the default, you'll have to make one file that works for both or else launch the MPF game engine and MPF MC separately (e.g. not using `mpf` both).

-h

Displays the command line help and exits. (Pretty much what's on this page.)

-f

New in version 0.32.

Forces MPF to load all assets at start (rather than the default behavior where some assets can be loaded only when modes start or based on other events). This is useful during development to ensure that all assets are valid and loadable.

-l (lowercase "L")

Specifies the name and path of the log file.

The default stores the log file in the /logs folder in your machine folder, with a file name of <year>-<month>-<day>-<hour>-<min>-<sec>-mpf-<hostname>.log.

Note that log files are standard log file formats that can be read and parsed with log file utilities. (The "Console" app is built-in to OS X, for example.)

-L (uppercase)

New in version 0.33.

Specifies the name and path of the log file.

Note this is the same as -l (lowercase L), but it's included so if you use *mpf both* with manually specified log files that you can use -l for the MPF log and -L for the MC log.

-v (lowercase)

Enables verbose logging to the log file. Warning: Your log files will be huge, perhaps 1MB per minute of game time. Definitely only use this when you're troubleshooting.

-V (uppercase)

Enables verbose logging to the console output.

Note that on due to the way the command prompt console works on Windows, enabling verbose logging on Windows will significantly affect MPF (in a bad way). Windows computers can run MPF no problem, but because of their weird console slowness we recommend that you do not use the -V command line option from a Windows computer.

-x (lowercase)

Ignores all platform: settings in your config files and forces MPF to run using the *virtual* platform interface. This is nice for testing when you don't have your physical hardware attached.

-X (uppercase)

Like -x, except it forces the *smart virtual* platform.

Unused Options

Note that command line options -a -A -x -X are valid but ignored by the MPF MC. This is because these options are used with the MPF game engine, but if you start the MPF game engine and MPF MC at the same time via `mpf` both, all options will be sent to both the game engine and the MC, so the MC ignores these options which it doesn't use.

`mpf migrate` (command-line utility)

Migrates config and show files built for prior versions of MPF to the current version.

`mpf monitor` (command-line utility)

Starts the *MPF Monitor*.

How to change the TCP ports MPF uses

Note: The functionality for changing the BCP port in the MPF-MC was added in MPF-MC v0.32.10.

Various MPF components talk to each other via a TCP socket protocol called BCP (which we invented). By default, MPF and MPF-MC each listen for incoming BCP connections on the following two TCP ports:

- 5050 MPF-MC
- 5051 MPF

When MPF-MC starts up, it starts listening on port 5050. If the MPF game engine doesn't connect, MPF-MC will sit there and wait for it. No problem.

When the MPF game engine starts, it attempts to connect to the MC on port 5050. If it can't make a connection, it will try again, and keep trying until a connection is made. (Note that you can control the behavior of this in the config files.)

The MPF game engine also listens for incoming BCP connections on 5051. This is not used by MPF-MC, but is used by other things that need to connect to MPF, such as the MPF Monitor.

If you have a port conflict (because something else on your system is using port 5050 or 5051), then you can change the MPF and MPF-MC ports to whatever you want. Just add the following two sections to your machine-wide config file. Note that you have to change it in two places, the "bcp" section which is what the MPF game engine reads to know what port the MC is listening on, and the "mpf-mc" section which is what the MC reads to know what port it should listen on.

Valid port numbers are anything between 1024 and 65535.

```
# config_version=4
```


bcp:

connections:

local_display: port: 1234

mpf-mc: bcp_port: 1234

Let's learn by example!

This tutorial will walk you through using MPF to create a basic pinball machine config. Since MPF is just software that supports lots of different physical hardware, you don't actually need to have physical pinball machine hardware to complete the tutorial. You can create a "virtual" pinball machine for now and then hook up a real machine later.

The tutorial includes:

- Configuring switches, coils, flippers, sling shots, and your trough.
- Starting and playing a complete game with multiple players.
- Setting up attract mode light and display shows.
- Basic scoring and defining shots and lights.
- Using the display to show what's happening and the score.
- Setting up a "base" game mode.

The idea is that everyone should follow the tutorial, and complete every step, in order. (The tutorial steps all build off the previous steps.) Once that's done, you can then move browse through the rest of the documentation to read specific "How To" guides for everything else you need. (These are in the Control Systems / Hardware, Pinball Mechanisms, Game Logic, Displays & Graphics, Sound, and Shows sections.)

Now let's get started. . .

Tutorial step 1: Prerequisites

The first step to using MPF is to understand some basics about how it works and to actually get MPF installed on your computer. So that's what these next few steps will do.

1. You don't need a physical pinball machine yet

First, you do *not* need to have physical hardware to go through this tutorial. You can complete the entire thing via MPF's "virtual" hardware platform which lets you run MPF on your computer with no actual hardware attached.

We should point out that MPF's virtual platform is *not* pinball emulation software. There is no 3D-rendered playfield, and it's not like Future Pinball or Visual Pinball or anything.

MPF is a bit different because it's designed to control a real, physical pinball machine, so when you run MPF's virtual platform interface, really all you're going to see is a lot of text and log messages as well as whatever's on your machine's DMD or LCD.

Still, it's enough to get started. We'll show you how to map keyboard keys on your computer so you can "play" your machine to test it out.

2. Read the overview of MPF

You certainly don't have to read through all the documentation to start this tutorial. However, the documentation is arranged in the order you should read it, so if you haven't read the documentation leading up to this point, please do that now. (If you're reading this online, start with the "[MPF Overview](#)" entry on the left. If you're reading a PDF, please turn to Page 1. :)

3. Check your MPF version

This tutorial is written for MPF versions 0.30-0.33, but if you're just starting out you should run the latest version. So let's see which version of MPF you have installed.

To do this, open a command prompt and run the following command:

```
mpf --version
```

That command should print something like MPF v0.30.1. Note that the version is three numbers, x.y.z. The last number (the "z") is the patch number and doesn't have any functional changes. (In other words, MPF 0.30.0 and 0.30.2 have the same functions and features.)

Tip: We highly recommend that you use the latest version of MPF, especially if you're starting out and don't have config files to migrate. To find out which version of MPF is the latest, visit the [MPF Users Google Group](#) and look at the banner welcome message at the top of the page.

If this command gives you an error, then go back to the [Downloading & Installing MPF](#) section to make sure MPF is installed. If it prints a version number lower than 0.30-0.33, then install the latest version of MPF. And if it shows that you have a newer version of MPF (based on the first two numbers), then go to docs.missionpinball.org to get the version of this documentation that matches the version of MPF you have.

4. Let's go!

If you're reading this tutorial online, note that there are "Previous" and "Next" navigation buttons at the bottom of each page. You should be able to just click those to follow along. (And if you'd like to

download a copy of this documentation to read offline, click the “Read the Docs” link at the bottom of the menu bar on the left for links to PDF, HTML, and Epub versions of this documentation.)

Tutorial step 2: Create your machine folder

Okay, so MPF is installed and you’re able to run *Demo Man*. Great! Now it’s time to create the folders and files for your own game.

1. Understand the “machine folder” concept

In MPF, we use the term *machine folder* to describe the folder that contains all the configuration files, code, images, videos, sounds, audits, and everything else you need for a pinball machine. Machine folders are portable, so you can grab a machine folder from one computer and run it on another—even if it’s a different platform. (Windows to Linux, Mac to Windows, etc.)

Note that we call these “machine” folders and not “game” folders because in MPF, a “game” is an actual game-in-progress running on a machine. So you’re really creating a pinball machine config, not a pinball game config.

2. Create your machine folders

Okay, so let’s get started with your own game’s machine folder. The first step is to create an empty folder somewhere. (Anywhere you want.) You can name this folder whatever you want too.

Let’s use the name “your_machine”, and we’ll assume you’re on Windows, so you might put it in your C:\pinball folder, like this:

```
C:\pinball\your_machine
```

Throughout this tutorial we’ll refer to this as “your machine folder”.

Next create a subfolder in your new machine folder called `/config`. This is where your machine configuration files will live. This folder should be inside your machine folder, like this:

```
C:\pinball\your_machine\config\
```

3. Create your machine config file

Now let’s actually create your machine config file. To do that, create a file called `config.yaml` in your `/config` folder. This will be your main config file which will ultimately be hundreds of lines long and which will contain all the config and settings for your machine. This file should be here:

```
C:\pinball\your_machine\config\config.yaml
```

Note that if you’re on Windows and you just right-click and select *New > Text Document*, make sure that Windows Explorer is configured to show file extensions so you actually create a file called `config.yaml` and not `config.yaml.txt`. (That’s in the “View” menu of Explorer.)

4. Add #config_version=4 to the top of your config file

The first thing you need to do when you create any new config file for MPF is to add an entry on the very top line that tells MPF what “version” of the MPF config spec you’re using for the file you’re creating. For MPF 0.30-0.33, that should look like this:

```
#config_version=4
```

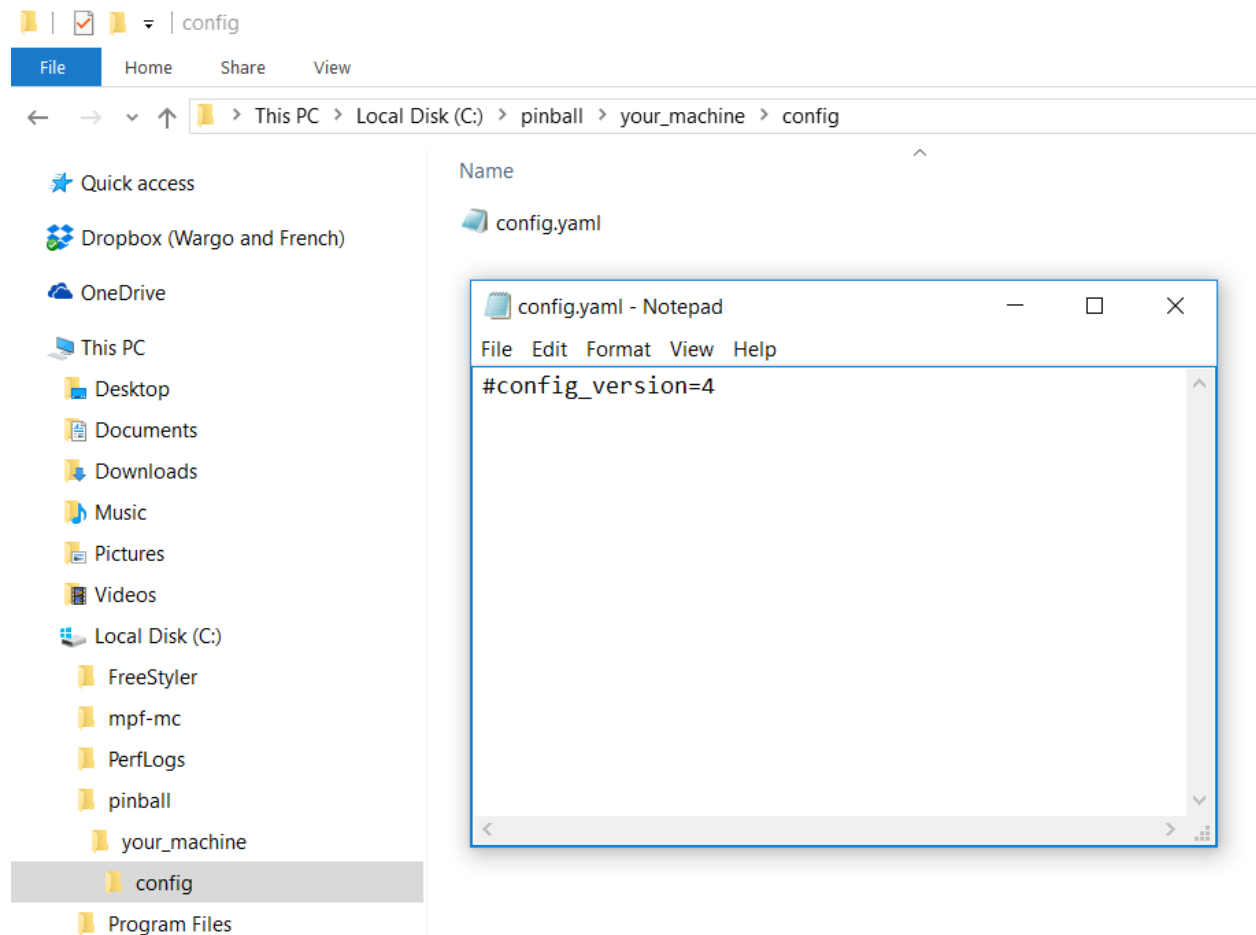
So just open the file (with a text editor or a free tool like [Atom](#) or [Sublime](#)) and then add that to the top of the file and save it.

Be sure to enter this exactly as it’s shown here, with no spaces around the equal sign.

This line tells MPF which version of the config spec you have. That way if a future version of MPF requires changes to a config file, it can automatically recognize older files and update them.

The current version of the config files is 4 which is what’s used with MPF 0.30 and newer, so that’s what we’re adding here.

At this point, your environment should look like this:



Note the folder structure, the location of the config.yaml file, and the #config_version=4 as the only contents of that file.

5. Run your game!

Believe it or not, it's time to run your game! Simply open a console window and change to your machine folder, and run `mpf -b`, like this:

```
C:\pinball\your_machine>mpf -b
```

Again, enter it as shown, with a space between `mpf` and `-b`. (The `-b` option tells MPF not to try to connect to a media controller for display and sound since we haven't set that up yet.)

You should get results that look something like this:

```
C:\pinball\your_machine>mpf -b
INFO : Machine : Mission Pinball Framework Core Engine v0.30.0
INFO : Machine : Machine path: C:\pinball\your_machine
INFO : Machine : Loading cached config: C:\Users\BRIANM~
1\AppData\Local\Temp\235c13dee169bec54dce4d06c2665fe9config
INFO : Machine : Starting clock at 30.0Hz
INFO : Mode.attract : Mode Starting. Priority: 10
```

You might notice that it seems like the command is hung because you didn't get the command line back. Actually what's happening is MPF is running! Your machine is live and sitting in the attract mode!!

At this point since we are running a completely blank config, the only way to stop MPF is to hit CTRL+C. When you do that, you should see a few more lines appear, like this:

```
INFO : Machine : Actual MPF loop rate: 32.04 Hz
INFO : root : MPF run loop ended.

C:\pinball\your_machine>
```

At this point you're all set! If your machine is working like this, go ahead and move on to the next step. However if you got something else on your display or some kind of error or crash, read on below...

What if it didn't work?

If you don't get an output that shows the attract mode running like the example above, there could be a few reasons for this, depending on the error.

If you get a crash with a message about a "Config file version mismatch", like this:

```
Traceback (most recent call last):
  File "z:\git\mpf\mpf\commands\game.py", line 130, in __init__
    MachineController(mpf_path, machine_path, vars(args)).run()
  File "z:\git\mpf\mpf\core\machine.py", line 98, in __init__
    self._load_config()
  File "z:\git\mpf\mpf\core\machine.py", line 290, in _load_config
    self._load_config_from_files()
  File "z:\git\mpf\mpf\core\machine.py", line 309, in _load_config_from_files
    config_type='machine'))
  File "z:\git\mpf\mpf\core\config_processor.py", line 99, in load_config_file
    config = FileManager.load(filename, verify_version, halt_on_error)
  File "z:\git\mpf\mpf\core\file_manager.py", line 155, in load
    round_trip)
```



```
File "z:\git\mpf\mpf\file_interfaces\yaml_interface.py", line 295, in load
    raise ValueError("Config file version mismatch: {}".format(filename))
ValueError: Config file version mismatch: C:\pinball\your_machine\config\config.yaml
```

This means you don't have `#config_version=4` in the top line of your config file. (Make sure you include the hash mark as part of that.)

If the following line at the end of your log and nothing more happens you probably started mpf with `mc` (i.e. by omitting the `-b` switch). This can be fixed by either running `mpf -b` or by making sure that the media controller is running.

```
BCPClientSocket.local_display : Connecting BCP to 'local_display' at localhost:5050...
```

If you get an error that says `Could not find machine folder: 'None'`, that means that you ran MPF from the wrong folder. For example:

```
C:\pinball\your_machine\config>mpf
Error. Could not find machine folder: 'None'.
```

This happens because the command prompt is in the child "config" folder, rather than the base machine folder. So `cd ..` up one level and try again.

```
C:\>mpf
Error. Could not find machine folder: 'None'.
```

Again, same thing here. The example above is in the root of C: which is not a valid machine folder. (It is possible to run a machine from another folder via command line options which is why this error says it couldn't find the machine "None" (since no command line options were passed), but for now just know that you need to run MPF from the root of your machine folder.

It's possible you might also get an error about "mpf" not being recognized. For example, on Windows:

```
C:\pinball\your_machine>mpf
'mpf' is not recognized as an internal or external command,
operable program or batch file.
```

Or on Mac or Linux:

```
$ mpf
-bash: mpf: command not found
```

In this case you probably don't have MPF installed right, so jump back to the installation part of the docs and follow that again.

Tutorial step 3: Get flipping!

There's something exciting about seeing the first flips from your own code, so in this step we're going to focus on getting your flippers working.

To do that, you have to add some entries to your config file to tell MPF about some coils and switches, then you have to group them together to tell MPF that they should act like flipper devices. So go ahead and open that `/config/config.yaml` file that you created in the previous step.

1. Add your flipper switches

The switches: section of your machine config file is where you list all the switches in your machine and map physical switch numbers to more friendly switch names. (This is what makes it possible to interact with switch names like “left_flipper” and “right_inlane” versus “switch 27” or “switch 19”.)

So on the line after the #config_version=4 entry from the previous tutorial step, write switches: (note the colon). Then on the next line, type four spaces (these must be spaces, not a tab), and write s_left_flipper:. Then on the next line, type eight spaces and add number:. Repeat that again for s_right_flipper:.

So now your config.yaml file should look like this:

```
#config_version=4

switches:
    s_left_flipper:
        number:
        tags: left_flipper
    s_right_flipper:
        number:
        tags: right_flipper
```

In case you’re wondering why we preface each switch name with “s_”, that’s a little trick we learned that makes things easier as you get deeper into your configuration. We do this because most text editors and IDEs have “autocomplete” functions where it will pop up a list to autocomplete values as you type. So if you preface all your switches with “s_” (and your coils with “c_”, your lights with “l_”, etc.), then as soon as you type “s_” into your YAML file you should get a popup list with all your switches which you can use to select the right one. These saves lots of headaches later caused by not entering the name exactly right somewhere. :)

If you use Sublime as your editor, it just does this automatically. Other editors might require plugins. (For example, you can add this functionality to Atom with a free package called “autocomplete-plus”.)

Notice that we added tags called left_flipper and right_flipper. These are optional, but recommended. The reason is that MPF includes a [combo switch](#) feature which posts events when player switches are held in combination. If you add these tags to your flipper switches, an event called *flipper_cancel* will be posted when the player hits both flipper buttons at the same time which you can use to cancel shows and other things you want the player to be able to skip.

When naming your switches (and most devices in MPF), your name can’t start with a number and it should only be a combination of letters, numbers, and underscores.

Also, the names you enter here are the internal names that you’ll use for these switches in your game code and configuration file. When it comes time to create “friendly” names for these switches which you’ll expose via the service menu, you can create plain-English labels with spaces and capitalization everything. But that comes later.

Finally, note that most things in MPF config files are case-insensitive, and MPF converts most things to lowercase. (Not everything, though. Certain things like labels and text strings will be in whatever case you enter them as. But in general stuff is case insensitive.)

The reason we mention this is because you can *not* have two things configured with the same name that only vary based on case sensitivity. For example, the switch names s_lane_trEk and s_lane_trek are not allowed since they’d both be converted internally to s_lane_trek.

Speaking of formatting files, let's look at a few important things to know about YAML files (which is the format of the file we're creating here):

- You cannot use tabs to indent in YAML. (It is [literally not allowed](#).) Most text editors can be configured to automatically insert spaces when you push the tab key, or you can just hit the space bar a bunch of times.
- The exact number of spaces you use for the indents doesn't matter (most people use groups of two or four), but what is absolutely important is that all items at the same "level" must be indented with the same number of spaces. In other words `s_left_flipper:` and `s_right_flipper:` need to have the same number of spaces in front of them. In a practical sense this shouldn't be a problem, because again most text editors let you use the tab key to automatically insert space characters.
- You cannot have a space between the setting name and the colon. GOOD: `switches:.` BAD: `switches :`
- You must have a space after the colon and the setting value. GOOD: `balls: 3`. BAD: `balls:3`
- Anything on a line following a hash sign `#` is ignored, so you can use this to add comments and notes to yourself.

This all might seem kind of annoying, but that's just the way it is with YAML files. When we started building MPF, we weighed the pros and cons of lots of different config file formats (XML, INI, JSON, TOML, text, Python, etc.), and YAML was the best trade-off in terms of having the features we needed while being the easiest to use.

By the way, at some point we'll create GUI tools you can use to build your configs instead of having to hand-edit YAML files, but that's probably a few years away, so in the meantime, get used to YAML. :)

2. Enter the hardware numbers for your switches

The `config.yaml` file you have so far is completely valid. However, you'll notice that the `number:` setting for each switch is blank. If you are not using MPF with a physical pinball machine yet, you can keep these numbers blank. But if you want to control a real pinball machine, you need to enter values for each switch's `number:` setting.

The exact number you enter for each switch is dictated by which switch input on your pinball controller each switch is connected to. However, different controllers use different number formats.

The [How to configure "number:" settings](#) guide explains how hardware numbering works on each of the various hardware platforms MPF supports, so check that out now and enter your real numbers, not the made-up ones we use below.

```
switches:
  s_left_flipper:
    number: 0 # this can be blank if you don't have physical hw yet
  s_right_flipper:
    number: 1 # if you do have physical hw, most likely your number will be different
```

3. Add your flipper coils

Next you need to add entries for your flipper coils. These will be added to a section called `coils:.` If you're using dual-wound coils, you'll actually have four coil entries here—both the main and hold coils

for each flipper. If you're using single-wound coils, then you'll only have one coil for each flipper (which we'll configure to pulse-width modulation for the holds).

If you have no idea what we're talking about, read our [Flippers](#) documentation for an introduction to flipper concepts, dual-wound versus single-wound, holding techniques, end-of-stroke switches, and a bunch of other stuff that's important that you probably never thought about.

Here's an example of how you'd enter your coils for a machine with two dual-wound coils. If you have single-wound coils, or you have more than two flippers, refer to the [Flippers](#) documentation for examples of how to configure them.

```
coils:
  c_flipper_left_main:
    number: 0 # again, these numbers will probably be different for you
  c_flipper_left_hold:
    number: 1 # check your platform-specific documentation for the actual numbers
    allow_enable: true
  c_flipper_right_main:
    number: 2
  c_flipper_right_hold:
    number: 3
    allow_enable: yes
```

Again, note each coil name is indented four spaces, and each "number" listed under them is indented eight spaces, there's no space before the colons, and there is a space after the colons. Like the switch numbers, the number: entry under each coil is the number that the pinball hardware controller uses for this coil. The exact number will depend on what type of controller hardware and driver boards you're using.

Also note that the two hold coils have allow_enable: entries added, with values of "yes" and "true". (In MPF config files, values of "yes" and "true" are the same, so we use one of each just to demonstrate to you that they're interchangeable.)

Anyway, the purpose of the allow_enable: setting is that as a safety precaution, MPF does not allow you to enable (that is, to hold a coil in its "on" position) unless you specifically add allow_enable: true to that coil's config. This will help to prevent some errant config from enabling a coil that you didn't mean to enable and burning it up or starting a fire.

So in the case if your flippers, the "hold" coil of a flipper needs to have allow_enable: true since in order for it to act as a flipper, that coil need to be allowed to be enabled (held on).

4. Add your flipper "devices"

Okay, you have your coils and switches defined, but you can't flip yet because you don't have any flippers defined. Now you might be thinking, "Wait, but didn't I just configure the coils and switches?" Yes, you did, but now you have to tell MPF that you want to create a flipper device which links together one switch and one (or two) coils to become a "flipper". MPF supports dozens of different types of [Pinball Mechanisms](#), some of which (like flippers), are created by combining other devices.

You create your flipper devices by adding a flippers: section to your config file, and then specifying the switch and coil(s) for each flipper. Here's what you would create based on the switches and coils we've defined so far:

```
flippers:
  left_flipper:
```



```

main_coil: c_flipper_left_main
hold_coil: c_flipper_left_hold
activation_switch: s_left_flipper
right_flipper:
  main_coil: c_flipper_right_main
  hold_coil: c_flipper_right_hold
  activation_switch: s_right_flipper

```

5. Try running MPF to make sure your config file is ok

At this point you should run your game to make sure it runs okay. Your flippers aren't going to work yet, but mainly we want to make sure MPF can read your config files and that there aren't any errors. Open a command prompt, switch to your machine folder, and run MPF again (like Step 2), also with the `-b` option:

```
C:\your_machine\mpf -b
```

The console output will look similar to Step 2 as well, and it won't look like much is happening here. The main thing is to make sure that MPF starts and runs without giving you any errors—meaning that everything you setup in your config file is ok.

```

C:\pinball\your_machine>mpf -b
INFO : Machine : Mission Pinball Framework Core Engine v0.30.0
INFO : Machine : Loading config from original files
INFO : Machine : Machine config file #1: C:\your_machine\config\config
INFO : Machine : Config file cache created: C:\Windows\temp\6454c58ed3dcbe5687dd7b0c0b112e00config
INFO : Machine : Starting clock at 30.0Hz
INFO : Mode.attract : Mode Starting. Priority: 10

```

At this point you can stop it by making sure your console window has focus and then hitting CTRL+C.

What if it didn't work?

If your game ran fine, then you can skip down to Step 6 below. If something didn't work or you got an error, then there are a few things to try depending on what your error was.

If the last line in your console output was something like this:

```

ValueError: Found a "switchs:" section in config file C:\your_machine\config\config, but that section_
↪is not valid in machine config files.

```

That means that it found a section in your config file that is not valid. Most likely this is due to a typo. For example, the above example has "switchs" instead of "switches".

Or maybe the error is more like this:

```

AssertionError: Config validation error: Entry flippers:left_flipper:main_coil:c_fliper_left_main is_
↪not valid.

```

This is showing that the flippers:left_flipper:main_coil:c_fliper_left_main entry is not valid. Again this is a typo—the coil name is spelled wrong (one "p" in flipper instead of two).

Or something like this:


```
AssertionError: Your config contains a value for the setting "flippers:left_flipper:holdcoil", but this_
↳ is not a valid setting name.
```

Again pretty self-explanatory. The setting `flippers:left_flipper:holdcoil` is not valid. (It should actually be `"hold_coil"`, not `"holdcoil"`.)

So you can see that we've tried to be pretty helpful when it comes to typos and config file errors. The trick is just to read through the output in the logs and to trace down what they're complaining about.

You might also get errors saying there's some kind of YAML problem. For example, if you remove the colon after the `coils:` section and re-run MPF, you get the following error:

```
ValueError: YAML error found in file /Users/brian/git/mpf-examples/tutorial/config/config.yaml. Line 16,
↳ Position 24
```

Line 16, Position 24. Pretty straightforward, except the missing colon is actually on line 15. This is because removing the colon still produced valid YAML until it hit the next line. The point is that if you get a YAML error, look a few lines above and below the line number from the error.

Again, recapping the rules of YAML:

- Be sure to indent with spaces, not tabs.
- Make sure that all the "child" elements are indented the same. So your `s_left_flipper` and `s_right_flipper` both need to be indented the same number of spaces, etc.
- Make sure you *do not* have a space *before* each colon.
- Make sure you *do* have a space *after* each colon.
- Make sure you have the `#config_version=4` as the first line in your file.

6. Enabling your flippers

Just running MPF with your game's config file isn't enough to get your flippers working. By default, they are only turned on when a ball starts, and they automatically turn off when a ball ends. But the simple config file we just created doesn't have a start button or your ball trough or plunger lane configured, so you can't actually start a game yet. So in order to get your flippers working, we need to add a configuration into each flipper's entry in your config file that tells MPF that we just want to enable your flippers right away, without an actual game. (This is just a temporary setting that we'll remove later.) To do this, add the following entry to each of your flippers in your config file:

```
enable_events: machine_reset_phase_3
```

We'll cover exactly what this means later on. (Basically it's telling each of your flippers that they should enable themselves when MPF is booting up, rather than them waiting for a ball to start.) So now the `flippers:` section of your config file should look like this: (If you have single-wound coils, then you won't have the `hold_coil:` entries here.)

```
flippers:
  left_flipper:
    main_coil: c_flipper_left_main
    hold_coil: c_flipper_left_hold
    activation_switch: s_left_flipper
    enable_events: machine_reset_phase_3
  right_flipper:
```



```
main_coil: c_flipper_right_main
hold_coil: c_flipper_right_hold
activation_switch: s_right_flipper
enable_events: machine_reset_phase_3
```

At this point the rest of the steps on this page are for getting your physical machine connected to your pinball controller. If you don't have a physical machine yet then you can skip directly to [Tutorial step 4: Adjust your flipper power](#).

7. Configure MPF to use your physical pinball controller

If you have a physical pinball machine (or at least a something on your workbench) which is hooked up to a FAST, P-ROC, P3-ROC, OPP, or Stern SPIKE controller, then you need to add the hardware information to your config file so MPF knows which platform interface to use and how to talk to your hardware. To configure MPF to use a hardware pinball controller, you need to add a `hardware:` section to your config file, and then you add settings for `platform:` and `driverboards:`.

Remember earlier in this step, we provided links to the documentation for each platform. Here they are again:

- [FAST Pinball](#)
- [Multimorphic P-ROC/P3-ROC](#)
- [Open Pinball Project \(OPP\)](#)
- [Stern SPIKE](#)
- [LISY](#)

You only need look at those docs for the specifics parts of the config that vary depending on your hardware. The good news is that 99.9% of the MPF config files are identical regardless of the hardware you're using.

Here are some various examples of different types of hardware configs. Please understand that these are just some examples! Do not copy them for your own use, rather, follow the instructions from the bullet list above.

FAST Pinball with FAST IO driver boards:

```
hardware:
  platform: fast
  driverboards: fast

fast:
  ports: com4, com5

switches:
  s_left_flipper:
    number: 00
```

P-ROC installed in an existing WPC machine:

```
hardware:
  platform: p_roc
  driverboards: wpc
```



```
switches:
  s_left_flipper:
    number: SF2
```

P3-ROC with P-ROC driver & switch boards:

```
hardware:
  platform: p3_roc
  driverboards: pdb

switches:
  s_left_flipper:
    number: 0-0
```

See? They're all different.

7a. Understand the “virtual” hardware

If you just added a platform: setting to your config file which specifies a physical hardware platform, now every time you run MPF with that config, it will try to connect to the physical hardware. But what happens if you want to use MPF without your physical pinball hardware attached? In that case, you can run MPF with either the `-x` or `-X` command line options. (Lowercase “x” is the “virtual” platform, and uppercase “X” is the “smart virtual” platform.)

We'll talk more about those later. The point is that if you have configured your machine for physical hardware and then you want to run MPF without the physical hardware, you need to add either `-x` or `-X` to your `mpf` command when you run it.

8. One last check before powering up

Okay, now we're really close to flipping. Before you proceed take a look at your config file to make sure everything looks good. It should look something like this one, though of course that will depend on what platform you're using, whether you have dual-wound or single-wound flipper coils, and what type of driver boards you have (which will affect your coil and switch numbers). But here's the general idea. (This is the exact file we use with a FAST WPC controller plugged into an existing *Demolition Man* machine.)

```
#config_version=4

hardware:
  platform: fast
  driverboards: wpc

switches:
  s_left_flipper:
    number: SF4
  s_right_flipper:
    number: SF6

coils:
  c_flipper_left_main:
    number: FLLM
```



```
c_flipper_left_hold:
    number: FLLH
    allow_enable: true
c_flipper_right_main:
    number: FLRM
c_flipper_right_hold:
    number: FLRH
    allow_enable: yes

flippers:
    left_flipper:
        main_coil: c_flipper_left_main
        hold_coil: c_flipper_left_hold
        activation_switch: s_left_flipper
        enable_events: machine_reset_phase_3
    right_flipper:
        main_coil: c_flipper_right_main
        hold_coil: c_flipper_right_hold
        activation_switch: s_right_flipper
        enable_events: machine_reset_phase_3
```

Note that the individual sections of the config file can be in any order. We put the hardware: section at the top, but that's just our personal taste. It really makes no difference.

9. Running your game and flipping!

At this point you're ready to run your game, and you should be able to flip your flippers! Run your game with the following command:

```
C:\your_machine\mpf -b
```

Watch the console log for the entry about the attract mode starting. Once you see that then you should be able to hit your flipper buttons and they should flip as expected! You might notice that your flippers seem weak. That's okay. The default flipper power settings are weak just to be safe. We'll show you how to adjust your flipper power settings in the next step of this tutorial. You'll also notice that switch events are posted to the console. State:1 means the switch flipped from inactive to active, and State:0 means it flipped from active to inactive.

```
INFO : SwitchController : <<<< switch: s_left_flipper, State:1 >>>>
INFO : SwitchController : <<<< switch: s_left_flipper, State:0 >>>>
INFO : SwitchController : <<<< switch: s_right_flipper, State:1 >>>>
INFO : SwitchController : <<<< switch: s_right_flipper, State:0 >>>>
```

Here's a companion video which shows running your game at this point in the tutorial based on the config file above: (Note that this companion video is showing *Judge Dredd*, and it's based on an older version of MPF, but the basic concepts are the same.)

<https://www.youtube.com/watch?v=SkxZxkHHmXw>

What if it doesn't work?

If your game doesn't flip while you're running this config, there are a few things it could be: If the game software runs but you don't have any flipping, check the following:

- Make sure you're *not* using the `-x` or `-X` command line options, since those tells MPF to run in with the “virtual” hardware (e.g. software-only) mode meaning it won't talk to your actual physical hardware.
- Verify that your switch and coil numbers are set properly. Remember the values of “0” and “1” and stuff that we used here are just for the sake of this tutorial. In real life your coil numbers are going to be something like A8 or FLLH or C15 or A1-B0-7, and your switches will be something more like E5 or 0/4 or SD12. Again look the how to guides for your specific platform for details on how their numbers should be set.
- Make sure you added `enable_events: machine_reset_phase_3` to each of your flipper configurations.
- Make sure your coin door is closed! If you're running MPF on an existing Williams or Stern machine, remember that when the coin door is open, there's a switch that cuts off the power to the coils. (Ask us how we knew to add this to the list. :)
- It's possible that your flippers are working, but their power level is so low that they're not actually moving. (In this case you might hear them click when you hit the flipper button.) In this case you can move on to the next step in the tutorial where we adjust the flipper power.

If MPF crashes or gives an error:

- If you're using a P-ROC and you get a bunch of really fast messages about *Error opening P-ROC device* and *Failed, trying again. . .*, this is because (1) your pinball machine is not turned on, (2) your P-ROC is not connected to your computer (via USB), or (3) you have a problem with the P-ROC drivers. If you're running MPF in a virtual machine, make sure the USB connection is set to go to the VM.
- If you're using FAST or OPP hardware and you get an error about a port configuration, or not being able to open a port, then make sure your port numbers are correct. If you were previously connecting to one of those ports via a terminal emulator, make sure you've disconnected from the port in that software before running MPF.

If a flipper gets stuck on:

- Really this shouldn't happen. :) But it did on our machine just now and we really really confused. :) It turns out it was our flipper button which was stuck in the “on” position. The *Judge Dredd* machine we were using at the time had those aftermarket magnetic sensor buttons with the little magnets on the button flags, one of them came unglued and slipped out of alignment, making the switch stuck in the “on” position.

If you're still running into trouble, feel free to post to the mpf-users Google group. We'll incorporate your issues into this tutorial to make it easier for everyone in the future!

Check out the complete config.yaml file so far

If you want to see a complete `config.yaml` file up to this point, there's a “tutorial” machine in the `mpf-examples` repo that you downloaded in Step 1. (This is the same repo that contains the Demo Man game that you ran in Step 1.)

The tutorial files are in the `tutorial` folder. If you just run MPF by itself from the tutorial game folder, you'll get an error:

```
C:\mpf-examples\tutorial>mpf
OSError: Could not find file Z:\git\mpf-examples\tutorial\config\config
```


This is because if you look in the `tutorial\config` folder, you see that there are lots of config files in there with names like `step3.yaml`, `step4.yaml`, etc., but there is not a file called `config.yaml`. Since MPF looks for `config.yaml` by default, it can't start because it can't find it.

However, you can use the `-c` command line option to specify the name of the config file that MPF should load instead of `config.yaml`. So if you want to run the example game from the tutorial associated with Step 3, it would just be this:

```
C:\mpf-examples\tutorial>mpf -c step3
```

That's telling MPF to start, using the file `C:\mpf-examples\tutorial\config\step3.yaml` as its config file.

Tutorial step 4: Adjust your flipper power

We casually mentioned in the previous step that MPF uses a very low default power setting for coils—mainly because we don't want to risk blowing apart some 40-year-old coil mechanism with a power setting that's too high. (Ask us how we know this! :)

So at this step in the tutorial, we're going to look at how you can adjust and fine-tune the power of your flipper coils. The good news is that everything you learn here will 100% apply to all the other coils in your machine (slingshots, pop bumpers, ball ejects, the knocker, drop target resets, etc.)

1. Adjust coil pulse times

Modern pinball controllers that MPF uses have the ability to precisely control how long (in milliseconds) the full power is applied to a coil. (Longer time = more power.) This is called the “pulse time” of a coil, as it controls how long the coil is pulsed when it's fired.

You can set the default pulse time for each coil in the coil's entry in the `coils:` section of your config file. If you don't specify a time for a particular coil, then MPF will a default pulse time of 10ms.

So in the last step, we got your flipper coils working, but as they are now, they each use 10ms for their pulse times. (Remember for flippers we're talking about the strong initial pulse to move the flipper from the down to up position. Then after that pulse is over, if you have dual-wound coils, the main winding is shut off while the hold winding stays on, and if you have single wound coils the pulse time specifies how long the coil is on solid for before it goes to the on/off pwm switching.)

So right now your flippers have a pulse time of 10ms. But what if that's too strong? In that case you risk breaking something. Or if your coil is too weak, then your ball will be too slow or not be able to make it to the top of the playfield or up all your ramps. So now you have to play with different settings to see what “feels” right.

Unfortunately there's no universal pulse time setting that will work on every machine. It depends on how many windings your coils have, how worn out your coils are, how clean your coil sleeves are, how tight your flipper bats are to the playfield, how free-moving your linkages are, and how much voltage you're using. Some machines have coil pulse times set really low, like 12 or 14ms. Others might be 60 or 70ms. Our 1974 Big Shot machine has several coils with pulse times over 100ms. It all really depends.

You adjust the pulse time for each coil by adding a `pulse_ms:` setting to the coil's entry in the `coils:` section of your config file. (Notice that you make this change in the `coils:` section of your config, not

the *flippers:* section.) So let's try changing your flipper coils from the default of 10ms to 20ms. Change your config file so it looks like this:

```
coils:
  c_flipper_left_main:
    number: 00
    pulse_ms: 20
  c_flipper_left_hold:
    number: 01
    allow_enable: true
  c_flipper_right_main:
    number: 02
    pulse_ms: 20
  c_flipper_right_hold:
    number: 03
    allow_enable: true
```

Notice that we only added `pulse_ms:` entries to the two main coils, since the hold coils are never pulsed so it doesn't matter what their pulse times are. Now play your game and see how it feels. Then keep on adjusting the `pulse_ms:` values up or down until your flippers feel right. In the future we'll create a coil test tool that makes it easy to dial-in your settings without having to manually change the config file and re-run your game, but we don't have that yet. You might find that you have to adjust this `pulse_ms:` setting down the road too. If you have a blank playfield then you might think that your coils are fine where they are, but once you add some ramps you might realize it's too hard to make a ramp shot and you have to increase the power a bit. Later on when you have a real game, you can even expose these pulse settings to operators via the service menu.

2. Adjusting coil “hold” strength

If you're using single-wound flipper coils, you should also take a look at the `hold_power:` values. (Again, to be clear, you only have to do this if your flippers have a single winding. If you have dual-wound coils then the hold winding is designed to be held on for long periods of time so you can safely keep it on full strength solid and you can skip to the next step.)

We don't have any good guidance for what your `hold_power:` values should be. Really you can just start with a value of 1 or 2 and then keep increasing it (whole numbers only) until your flipper holds are strong enough not to break their hold when a ball hits them. Each hardware platform has additional options for fine-tuning the hold power if you find the values of 1-8 result in weird buzzing sounds or don't feel right. See the *coils:* section of each hardware platform's How To guide for details for your platform.

By the way there are a lot of other settings you can configure for your flippers. (As detailed in the *flippers:* section of the config file reference.) They're not too important now, but we wanted to at least look at the power settings to make sure you don't get too far into this tutorial with a risk of burning them up.

3. Check out the complete config.yaml file so far

If you want to see a complete `config.yaml` file up to this point, it's available in the “tutorials” folder of the `mpf-examples` package that you should have downloaded in Step 1 of this tutorial.

There are config files for each step, so the config for Step 4 should be at `/mpf-examples/tutorial/config/step4.yaml`.

You can run this file directly by switching to that folder and then running the following command:

```
C:\mpf-examples\tutorial>mpf -c step4
```

Tutorial step 5: Add a display

In this step, we're going to add a graphical on-screen window which will help show what's happening in your machine as it runs. If you're planning to put an LCD display in the backbox of your machine, this is what we'll set up now. And if you want to use a physical DMD (whether it's an older-style mono DMD, or a newer full color LED-based DMD), you'll be able to use the screen window we set up in this step to show a software version of your DMD.

Regardless of what type of display you want to use in your final machine, follow this step in the tutorial and then you can set up your final display later.

1. Run the media controller to see how it works

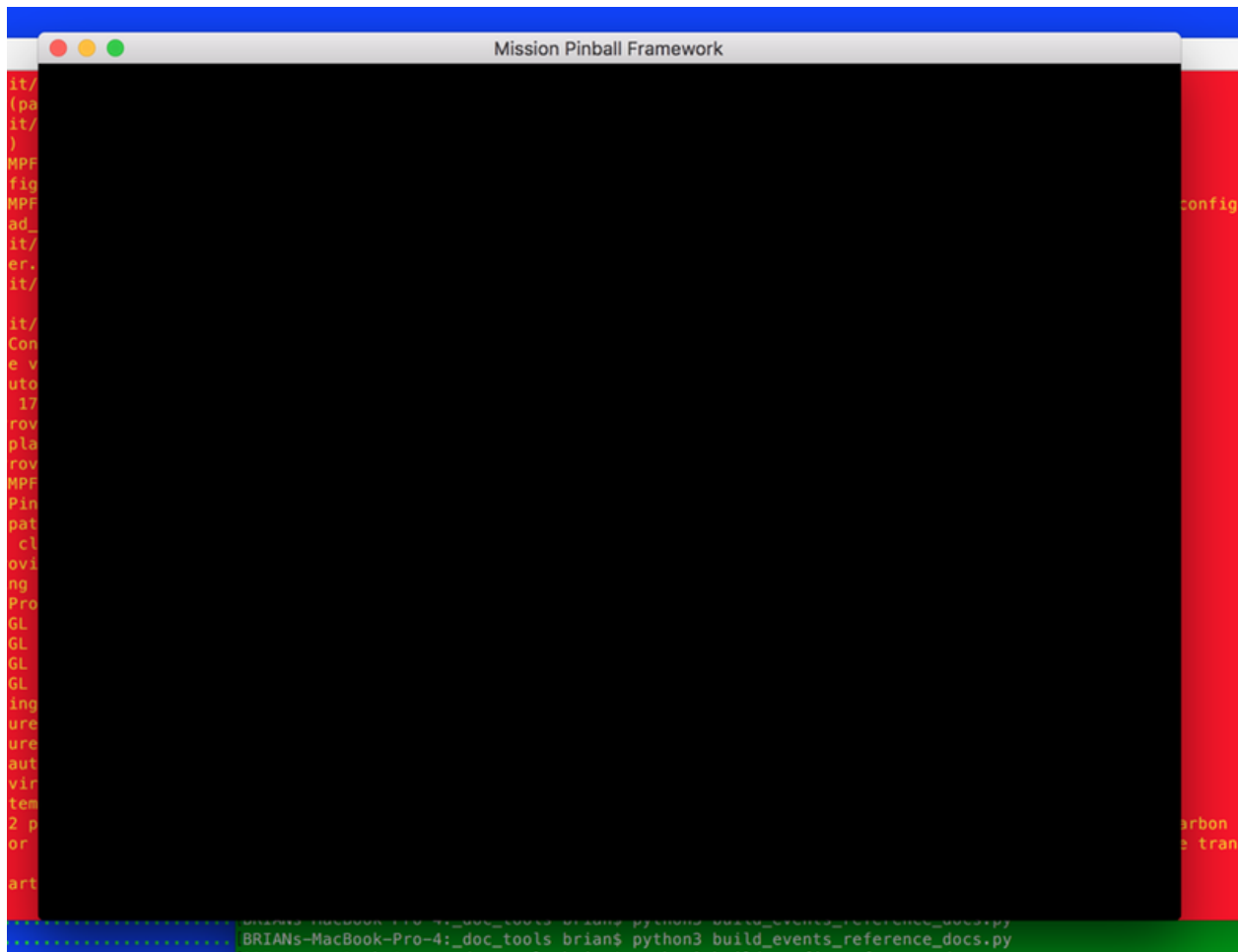
Remember from the MPF [MPF Overview](#) section (you read that, right?) that MPF is actually two separate pieces—the *game engine* and the *media controller*.

Up until this point in the tutorial, we've been running the MPF game engine only. In this step, since we're adding a display, we'll be working with the media controller.

So first, let's run the MPF media controller from your machine folder so you can see how it works. You do that with the `mpf mc` command, like this:

```
C:\pinball\your_machine>mpf mc
```

When you do this, you should see an 800x600 popup window that's completely black with the title "Mission Pinball Framework". Here's an example from Mac OS X:



You can close this window (and exit the MPF MC) by hitting the Esc key. (If this doesn't work, click your mouse in the popup window to give it focus and try again.)

You can also exit the MPF MC and close the popup window from the command line via CTRL+C.

2. Add a “display” to your config file

Now that you know how to run the MPF media controller (or “MPF-MC”, as we often call it), let's configure your machine config so that window actually shows some content.

The MPF game engine and MPF-MC both read the same configuration files, so we'll be editing the same `config.yaml` file we've been working with all along.

The first step is to create a “display” in your MPF config, which is like an internal representation of a blank canvas that holds graphical content which can be shown on an LCD screen or a DMD. The MPF-MC can have multiple display canvases at the same time, and you can map different ones to different physical displays. (This means ultimately you can support multiple displays at the same time.)

The only setting for each display we need to worry about now is the height and width, both defined in terms of the number of pixels. So for now, create a single display called “window” set to 800x600 pixels. To do this, add the following to your `config.yaml` file:


```
displays:
  window:
    width: 800
    height: 600
```

Make sure that the word `displays:` has no spaces in front of it, since it's a top-level config item.

Note that in the example above, we used 2 spaces for the indentation instead of 4. That's fine, YAML doesn't care. (And you can even mix-and-match in the same file.) The only spacing thing that matters is items at the same level are indented the same number of spaces (like "width" and "height"). Also, no tabs.

The configuration above is creating a display called "window" which MPF will automatically map to the on screen popup window. There are more options here (especially when you get to using multiple displays) covered in the [Displays, DMDs, & Graphics](#) section of the documentation, but we don't need to worry about that.

Also, again, if your machine is going to use a physical DMD (whether mono or color), or if you want to have the "dot look" of an on-screen DMD on an LCD screen, for now just follow along the tutorial as is, and then you can read full display documentation afterwards to configure your displays. Everything we do in the tutorial will transfer over even if you ultimately use a different kind of display.

3. Add a slide & a text widget

Ok, so now we have a display called "window". If you run `mpf mc`, you will still see the black popup window (just like Step 2) since we haven't actually told the window to show anything. So in this step, we're going to add some content to the window display, starting with some simple text.

To do this, you need to understand some basic concepts about how the display system works in the MPF media controller.

Since the folks who originally started MPF spend a lot of time giving presentations, the display concepts and terminology are pulled from presentation software like Microsoft PowerPoint or Apple Keynote. So if you're familiar with those, you should be familiar with the display concepts in the MPF MC.

First is the concept of [slides](#). Just like a PowerPoint presentation, an MPF display is essentially a window frame that shows slides. Many slides can exist, but only one is shown at a time, and that slide takes up the entire display. (Just like how a PowerPoint slide takes up the whole display when you're playing the slide show.)

In MPF-MC, when one slide switches to another, there can be an animated "transition", like fade, push in, move out, etc.

A slide is like a blank canvas that you put things on. The "things", in this case, are called [widgets](#). MPF has different types of widgets, for example, text, images, videos, shapes, lines, etc. When you put a widget on a slide, you can specify all sorts of properties, like the size, position, alignment, colors, etc.

One slide can have lots of different widgets, and you can specify the order widgets are drawn to control which ones are "on top" of others. You can add and remove widgets from existing slides at any time, and you can also animate widget properties, meaning you can change the opacity (to make them flash), or you can animate their position, size, etc.

All of this will become more clear throughout the tutorial, so let's just jump right in.

In order to show some text, we first have to create a slide, add a text widget to that slide, and make that slide the active slide on the display.

So first let's create the slide. There are several ways to do this, so we're just going to show you one way here and then you can read the full documentation on [slide](#) later.

In MPF, all slides have names. You can define slides in the `slides:` section of the config. So let's create a slide called "welcome_slide", like this:

```
slides:
  welcome_slide:
```

Now let's add a `widgets:` section under that slide, then under that, we'll start creating some widgets.

```
slides:
  welcome_slide:
    widgets:
```

You can add as many widgets as you want to a slide. (And it's pretty common for slides to be made up of lots of widgets). For now let's add a text widget that reads "PINBALL!". Do this by adding the following to your config:

```
slides:
  welcome_slide:
    widgets:
      - type: text
        text: PINBALL!
```

There are a few things going on there.

First, notice that before the word `type:`, there's a dash (hyphen), followed by a space. This is how you specify a list of items in YAML. (Think of it kind of like the YAML version of a bullet list.) You need to do this when adding widgets to a slide since a single slide can have more than one widget, so the dash tells the YAML file (and MPF-MC) where the settings for one widget end and the next begin.

Second, the space AFTER the dash is important. WRONG: `-type: text` RIGHT: `- type: text`

The `type: text` line is telling MPF-MC that this entry is for a text widget. And the `text: PINBALL!` is setting the text for this widget to be "PINBALL!". (For now we're just hard-coding the text to be "PINBALL!", but in the future we'll look at how you can use dynamically-updating text (like for the player score) that updates automatically whenever it changes.

Now run `mpf mc` and what do you see?

A blank window again! :(

The reason the window is still empty is because even though we created a slide (called "welcome_slide") and we added a widget to that slide, we didn't actually configure MPF-MC to *show* that slide. So let's do that now.

4. Add a slide_player config

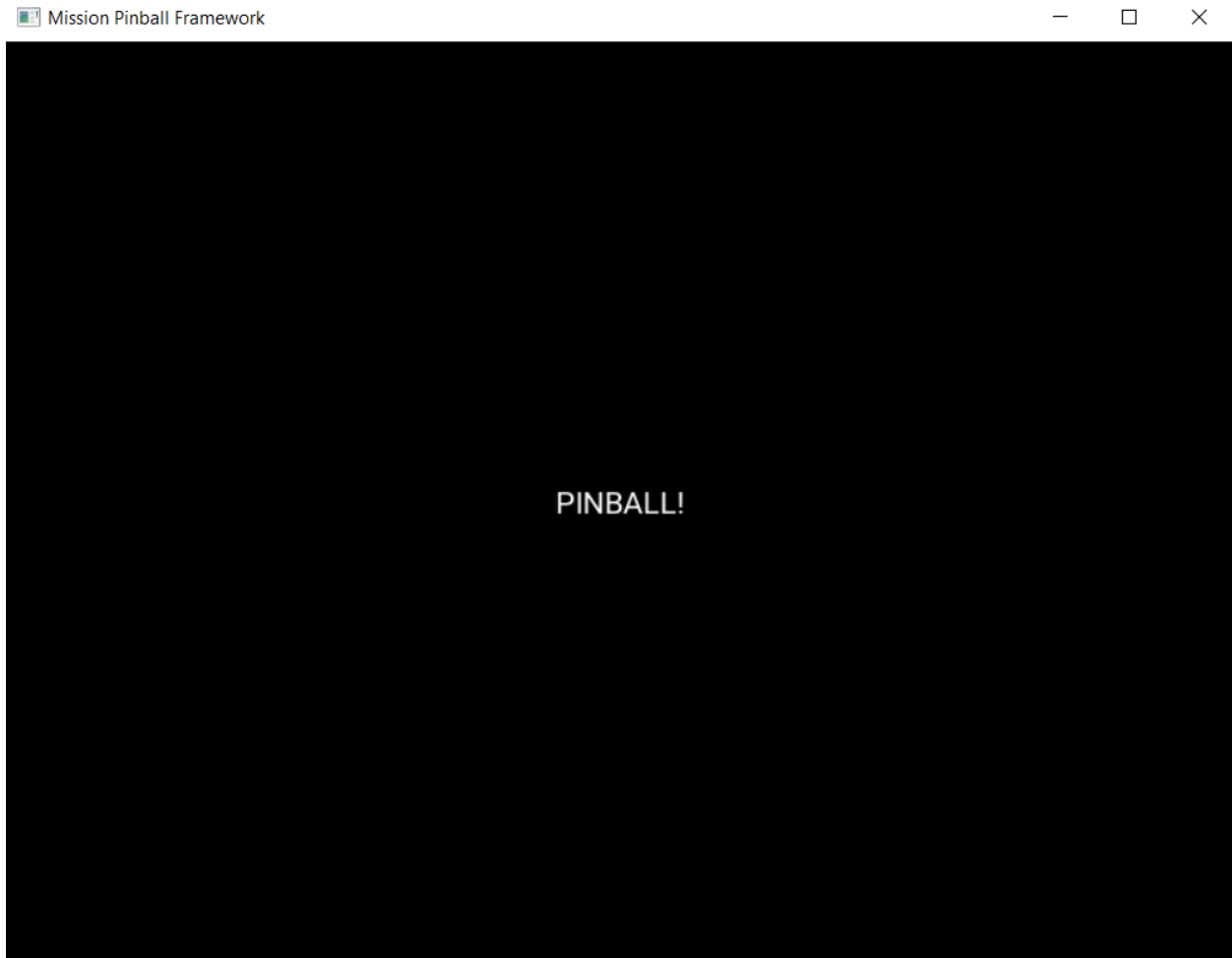
Next, create a new section in your config called `slide_player:`. The `slide_player` watches for certain events to occur, and when they do, it "plays" a slide.

To see this in action, add the following section to your machine config:


```
slide_player:  
    init_done: welcome_slide
```

What this is doing is saying, “When the event called *init_done* happens, play the slide called *welcome_slide*.” The *init_done* is an event that’s posted by MPF-MC at the earliest possible point when it is ready after it initially starts up (literally it’s saying “the MC is ready”). So what we’re doing here is telling MPF-MC to show our welcome slide as soon as it can. (Check out the [events](#) documentation for details on what events are.)

To verify, run `mpf mc` again, and hopefully you see something like this:



Cool! We have text! Of course it’s kind of small, and white, but it confirms that everything is working. Again, what’s actually happening here is:

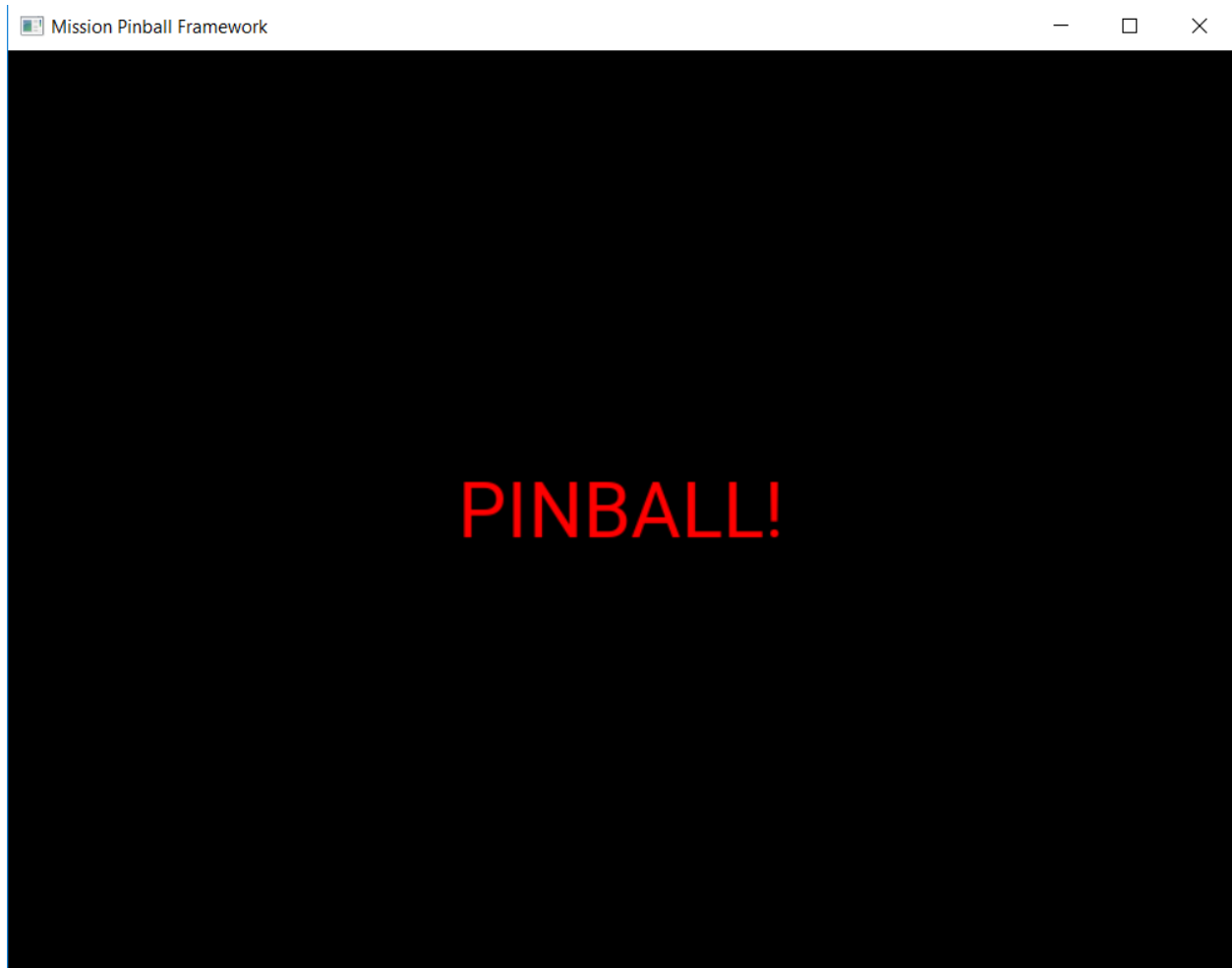
- You have a display called “window”,
- which is showing a slide called “welcome_slide”,
- because the `slide_player` was configured to show that slide when the “init_done” event happened, and
- that slide has a single widget,
- which is a text widget with its text set to “PINBALL!”.

There are lots of settings for each widget type that you can use in your config file. Since this is a text widget, we can look at the [documentation for text widgets](#) to see what options we have.

For example, let's change the font size and the color, by adding `font_size:` and `color:` lines:

```
slides:
  welcome_slide:
    widgets:
      - type: text
        text: PINBALL!
        font_size: 50
        color: red
```

Now when you run `mpf mc` again, you should see this:



By default, the widget is centered in the slide, but you can play with different settings to position it wherever you want. (Check out [How to position widgets on slides](#) for details.)

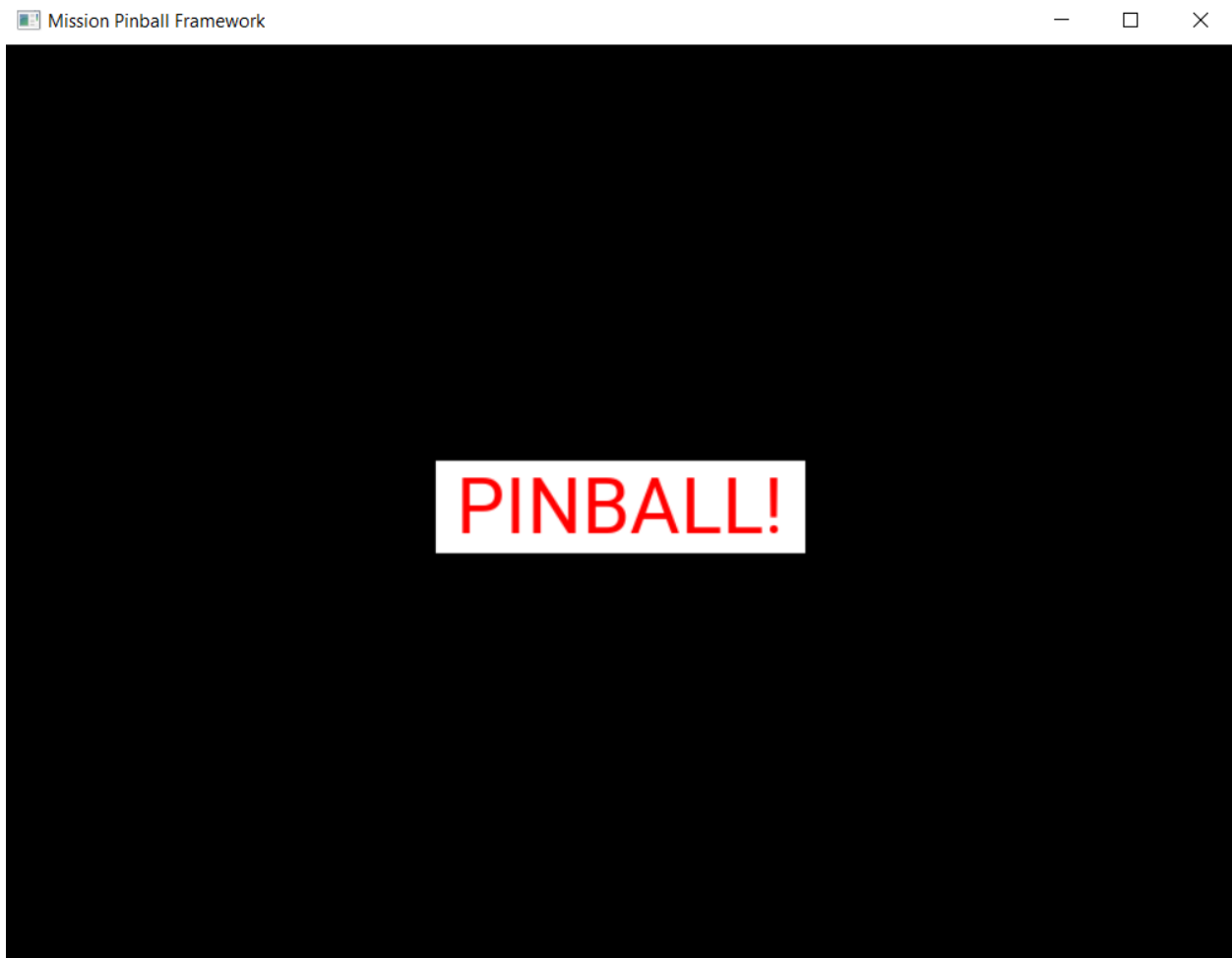
5. Add a second widget

We already mentioned that you can add as many widgets as you want to a slide and that there are lots of different kinds of widgets. Let's add a second widget to your welcome slide. This one will be a rectangle which appears behind the word "PINBALL!".


```
slides:
  welcome_slide:
    widgets:
      - type: text
        text: PINBALL!
        font_size: 50
        color: red
      - type: rectangle
        width: 240
        height: 60
```

Again, note that you use a dash followed by a space to denote the start of the second widget. This widget's type is "rectangle", with its height and width specified. Since we're not specifying any position, it will be centered (just like the text widget), and since we're not specifying a color, it will be white.

Now when you run `mpf mc`, you should see this:



Note that the word "PINBALL!" is "on top" of the white rectangle. That's because the order of the widgets on the display matches the order they're entered into the config file. So in this example, since the text widget comes first in the list of widgets for the welcome slide, the text widget is on top. If you switch the order and run `mpf mc` again, you'll just see the white rectangle with no text, since the rectangle would be "on top" and it would completely cover the PINBALL! text.

6. Run MPF-MC and the MPF game engine at the same time

Ok, so now you're able to run the media controller to get some widgets to show up. But so far, you were just running `mpf mc` which is running the media controller by itself, without the MPF game engine running.

So in this step, we're going to run them both at the same time.

The first thing you need to do is add another slide to your config for the MC to play, and this time we'll make that slide play on a different event.

So in your `slides:` section, add another slide called `attract_started`, like this:

```
slides:
  welcome_slide:
    widgets:
      - type: text
        text: PINBALL!
        font_size: 50
        color: red
      - type: rectangle
        width: 240
        height: 60
  attract_started:
    widgets:
      - text: ATTRACT MODE
        type: text
```

Note that `attract_started:` is indented the same number of spaces as `welcome_slide:`. Also note that in the `attract_started` slide, we switched the order of `text:` and `type:`. We did that here just to demonstrate that the order of settings in the config doesn't matter.

If you run this, nothing different will happen because all we did here in the `slides` section is define a slide. We need to use the `slide_player:` section to actually play the slide when some event happens.

So next, go to the `slide_player:` section of your config and add an entry for the event `mode_attract_started`. (This is the event that is posted whenever a mode starts, in the form of `mode_<mode_name>_started`.)

By the way, if you're wondering how we know what events to use, there's an [event reference](#) in the documentation which has a list of all the events in MPF as well as descriptions of when they're posted. You can use any of these as triggers for your slides via the `slide_player:`.

Anyway, add the `mode_attract_started` to your `slide_player:` like this:

```
slide_player:
  init_done: welcome_slide
  mode_attract_started: attract_started
```

Again, this is saying you want the slide called "attract_started" to play when the event called "mode_attract_started" happens.

Now run `mpf mc` again. At this point you should see the welcome slide with the PINBALL! text. (You see the welcome slide because the MPF game engine isn't running, and the game engine is responsible for starting and stopping modes. So no game engine means no attract mode, and no attract mode means no `attract_mode_started` event, which means no `attract_started` slide.)

Now open a second terminal window and switch into your game folder and launch the MPF game engine. Remember from prior steps that we ran MPF with the `-b` option which told MPF to *not* try to connect to the MPF-MC. But now we have the MC running, so we want to run MPF without `-b` so it connects.

So this time, just run `mpf`, like this:

```
C:\pinball\your_machine>mpf
```

When you run MPF, after some stuff scrolls by, you should see the `attract_started` slide replace the `welcome_slide`, like this:

```

Z:\git\mpf-examples\tutorial>mpf mc
INFO : kivy : Factory: 179 symbols loaded
INFO : kivy : Image: Providers: img_tex, img_dds, img_gif, img_...
INFO : kivy : VideoGstPlayer: Using Gstreamer 1.4.5.0
INFO : kivy : Video: Provider: gstplayer
INFO : kivy : Loading MPF-MC controller
INFO : mpfmc : Mission Pinball Framework Media Controller v0.30.0
INFO : mpfmc : Machine path: Z:\git\mpf-examples\tutorial
INFO : mpfmc : Starting clock at 30.0Hz
INFO : kivy : Text: Provider: sdl2
INFO : kivy : OSC: using <thread> for socket
INFO : kivy : Window: Provider: sdl2
INFO : kivy : GL: GLEW initialization succeeded
INFO : kivy : GL: OpenGL version <b'3.0 Mesa 10.6.0 (git-9c42128...
INFO : kivy : GL: OpenGL vendor <b'VMware, Inc.'>
INFO : kivy : GL: OpenGL renderer <b'Gallium 0.4 on SVGA3D; built...
INFO : kivy : GL: OpenGL parsed version: 3, 0
INFO : kivy : GL: Shading version <b'1.30'>
INFO : kivy : GL: Texture max size <16384>
INFO : kivy : GL: Texture max units <16>
INFO : kivy : Window: auto add sdl2 input provider
INFO : kivy : Window: virtual keyboard not allowed, single mode...
INFO : SoundSystem : SoundSystem: Using default 'sound_system' s...
INFO : AudioInterface : Initialized 0.30.0-dev16
INFO : BCP : Starting up on localhost port 5050
INFO : BCP : Waiting for a connection...
INFO : kivy : Base: Start application main loop
INFO : kivy : GL: NPOT texture support is available
INFO : BCP : Received connection from: 127.0.0.1:56167

Z:\git\mpf-examples\tutorial>mpf
INFO : Machine : Mission Pinball Framework Core Engine v0.30.0
INFO : Machine : Machine path: Z:\git\mpf-examples\tutorial
INFO : Machine : Loading config from original files
INFO : Machine : Machine config file #1: Z:\git\mpf-examples\tutorial\config\config1.json
INFO : Machine : Config file cache created: C:\Users\BRIANM-1\AppData\Local\Temp\1a2ac6a5c7f21da84ce089ed9a830d644config
INFO : Machine : Starting clock at 30.0Hz
INFO : BCPClientSocket.local_display : Connecting to BCP Media Controller at localhost:5050...
INFO : Mode.attract : Mode Starting. Priority: 10
  
```

So now MPF is running, it's talking to the MC, and you have the world's most boring attract mode!

To quit MPF, just make sure the graphical window has focus and hit the `Esc` key. That should cause both the MPF game engine and the MC to exit. (If they hang for some reason, you can click in the console window of the one that's hanging and press `CTRL+C` to kill it.)

Note that in the screen shot above, the colors of the command windows were changed. The magenta window is where `mpf mc` was run, and the blue window is where `mpf` was run.

Since the `attract_started` slide only has one widget, and since all we did with that widget is specify text (but not size, color, position, font, etc.), we just get the default text properties which are small, arial, and white.

7. Launching the MPF game engine and MPF MC at the same time

In the previous step, you used two separate console windows to launch `mpf mc` and `mpf` separately. (If you do this, by the way, you can launch either one first and it will wait for the other one.)

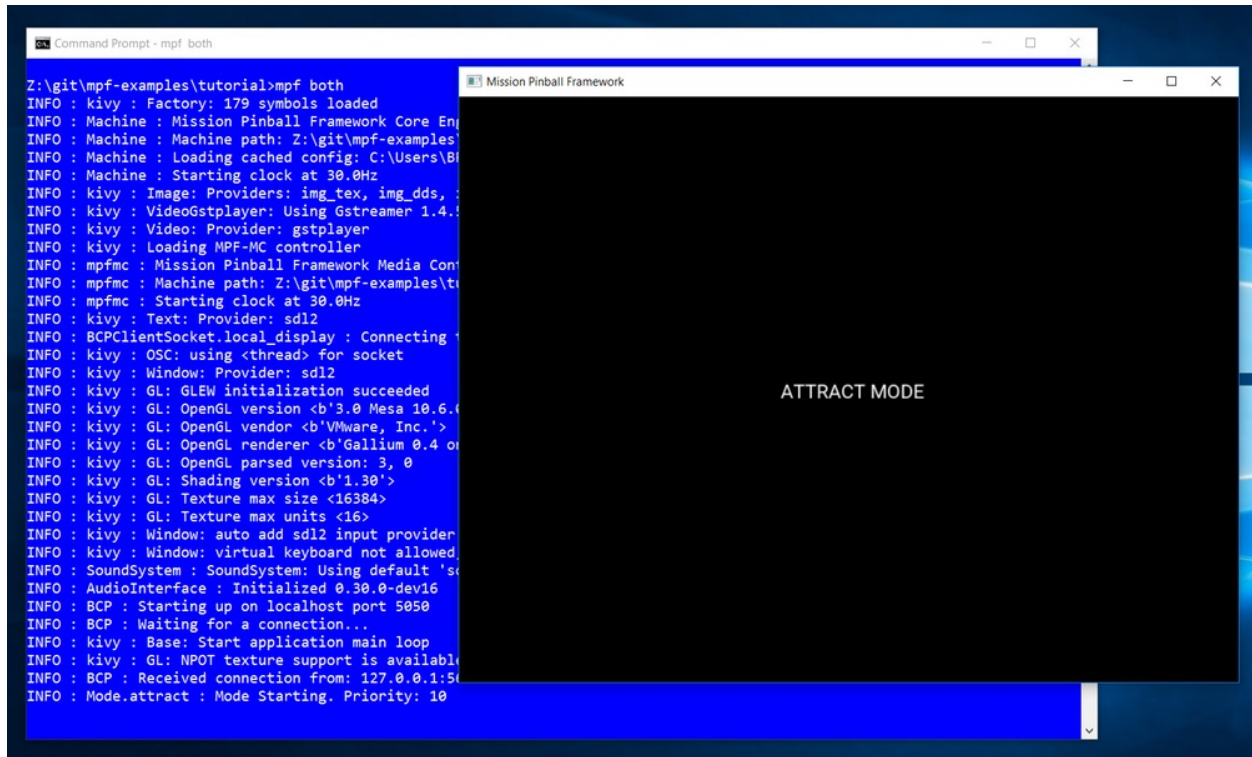
That's nice for learning purposes, but kind of annoying for everyday use. Fortunately there's a command called `mpf both` which launches both the game engine and the MC together.

Note: If you're using a Mac, you need to use MPF 0.32 or newer for `mpf` both to work.

Use it just like the others:

```
C:\pinball\your_machine>mpf both
```

When you do this, you should see the graphical window pop up (most likely showing the *welcome_slide* for a quick flash), then when the MPF game engine is up and running, you should see the graphical window flip over to the *attract_started* slide. Here's a screen shot:



Check out the complete config.yaml file so far

If you want to see a complete `config.yaml` file up to this point, it's available in the "tutorials" folder of the `mpf-examples` package that you should have downloaded in Step 1 of this tutorial.

There are config files for each step, so the config for Step 5 should be at `/mpf-examples/tutorial/config/step5.yaml`.

You can run this file directly by switching to that folder and then running the following command:

```
C:\mpf-examples\tutorial>mpf -c step5
```

What if it doesn't work?

If you can't get it to work, there are a few things to look at.

If you get some kind of “KeyError” like `KeyError: 'welcome_slide'`, that means that it’s looking for something it didn’t find. Most likely this is the slide player looking for a slide that doesn’t exist, so make sure the slide’s entry in the `slides:` section matches the slide’s name in the `slide_player:` section.

If the welcome slide works but you never see the attract slide, make sure you have the `mode_attract_started:` event name spelled properly. Also make sure you do *NOT* run MPF with the `-b` option since that tells it not to connect to the MC.

Most of the other errors should be pretty self-explanatory. If you get stuck, feel free to post to the [mpf-users Google group](#).

Tutorial step 6: Add keyboard control

Once you get to this point, you should be able to run the MPF game engine as well as the media controller, and you should have a pop-up window which shows some text. You should have your flippers configured, and if you have a physical machine connected, you should be able to flip.

In this step, we’re going to add some keyboard settings to your machine config which will let you map keyboard keys on your computer to switches in your pinball machine. This lets you “play” your game on your computer, which is useful for (1) cases where you don’t have a physical machine nearby, and (2) scenarios where your pinball machine is all the way on the other side of the room and you don’t feel like getting up every time you start MPF.

1. Create your key-to-switch mappings

The first step is to create your key-to-switch mappings in your config file. You do this by adding a `keyboard:` section, and then in there you add entries for each keyboard key and what type of action in MPF you want to map them to. (Switches, in this case.)

Here’s an example where we map the left flipper button to the Z key and the right flipper button to the `?` key:

```
keyboard:
  z:
    switch: s_left_flipper
  "?":
    switch: s_right_flipper
```

Note that the question mark is in quotes since it’s a non-standard character, and if you don’t put it in quotes, it will confuse the YAML parser.

Also it’s weird that the key is the question mark, because if you push that key normally it types a slash. (The question mark is the shift option for that key.) So if you set a key mapping and it doesn’t work, try the other character on the key.)

Again make sure that you have proper YAML formatting. The `z:` and `"?":` entries should be indented the same number of spaces, and the “switch” words should be indented further. Also make sure you have a space to the right of the colon after `switch:`. At first you might think it’s a bit tedious to have to write the word “switch” for each line. After all, why can’t you just enter them as `z: s_left_flipper`? This is because the MPF keyboard interface can actually be used to control [a lot more than just keys](#). The details of that are not important now, so for now just make sure your `keyboard:` section looks like the example above.

2. Test your new keyboard interface

At this point we're ready to test this out. Pretty simple. Save your config file and run your game again. (Seriously, we can't tell you how many times things don't work only to realize we didn't save our config after changing it!). So now run your game, starting both the media controller and the MPF core. Again you can either do this by running both commands manually in separate windows or by running `mpf both`.

Note that if you have a physical machine connected, *your physical flippers will not flip with the keyboard keys*.

Let's repeat this to be clear. If MPF is connected to physical hardware, pushing flipper button keys on your keyboard will not actually operate your physical switches. (We'll cover why not in Step 3 below.)

In order for the keys to work, the catch is that the graphical popup window (the one with the attract mode slide in it) has to be the active window for it to receive the keys. (It has to have "focus", in OS parlance.) Just like how your typing is only sent to the current active window on your desktop, the media controller's graphical window has to be active for your game to see your keystrokes and convert them to switches. So make sure this window is active (you can ALT+TAB to it or click on it).

Then try hitting the "Z" and "/" keys, and you should see them show up in your console window which is running the MPF game engine as MPF switch events, like this:

```
INFO : SwitchController : <<<< switch: s_left_flipper, State:1 >>>>
INFO : SwitchController : <<<< switch: s_left_flipper, State:0 >>>>
INFO : SwitchController : <<<< switch: s_right_flipper, State:1 >>>>
INFO : SwitchController : <<<< switch: s_right_flipper, State:0 >>>>
```

When you hit a key that you've configured on your keyboard, it's actually received by the media controller which in turn converts it to switch name and sends it to the MPF game engine. (This is because the MC controls the popup window, not MPF, and you need a window to track key states.)

Notice that there are actually state changes each time you hit and release a key. The "State: 1" means that switch has become active (i.e. when you press down the key), and the "State: 0" means that switch has just become inactive (when you release the key). You can experiment with this by holding down a key and seeing the log event for the associated switch becoming active, and then when you release it you'll see that switch becoming inactive. Go ahead and play around with this, and notice that you can push and hold the two keys in different orders and combinations.

3. Why can't you "flip" your physical machine with the keyboard?

If you're working with a physical machine with this tutorial, you might be surprised to see that your flippers don't fire when you hit the Z or / keys! Even more confounding is that you will still see the flipper switch events in your console log, and if you reach over and hit the physical buttons on your machine, the flippers will work. So what gives?!?

This happens because MPF uses "hardware rules" to program quick-response mechanisms (like flippers), meaning the flippers are activated by the control system rather than MPF software.

Read the *How MPF handles "quick response" mechs (flippers, slingshots, etc.)* guide for details.

What if it doesn't work?

If you don't see your switch events in the console when you press your keys, there are a few things you can try to troubleshoot:

- Double-check to make sure you actually saved your updated config file. :)
- Make sure no modifier keys (shift, control, etc.) are being pressed at the same time. Since there are way more switches in a pinball machine than keys on a keyboard, MPF lets you add modified keys to your keyboard: map. This means that MPF will see Z, SHIFT+Z, CTRL+Z, SHIFT+CTRL+Z, etc. all as different switches.
- Remember that the media controller's pop-up window has to be in focus. Make sure it's the active window on your desktop and try hitting your keys again.
- Remember that your physical flippers will not flip if you hit the keyboard keys for your flipper buttons.

Check out the complete config.yaml file so far

If you want to see a complete config.yaml file up to this point, it's in the mpf-examples/tutorial folder with the name step6.yaml.

You can run this file directly by switching to that folder and then running the following command:

```
C:\mpf-examples\tutorial>mpf both -c step6
```

Tutorial step 7: Add your trough

At this point you have a flipping machine with a display, but you don't have a "working" pinball machine since you can't start or play games.

So the next two steps in this tutorial, we're going to get your first two *ball devices* set up—your trough and plunger lane. (A ball device is anything in MPF that holds a ball.

1. Read about ball devices

In MPF, a "ball device" is any physical mechanism in your machine that holds a ball.

You can read more about ball devices in the [Ball Devices](#) documentation, which we recommend that you do now to familiarize yourself with the concepts. (You don't have to understand everything about them for now, just skim through that link so you get the basics.)

2. Add your trough and/or drain

Now that you understand what a ball device is, let's add your first ball device, which is going to be trough (or drain) device which collects balls that drain from the playfield and stores them while they're not in play.

Since there are so many different types of ball drain and trough configurations, we can't write a single tutorial that walks you through all of them.

Instead, we have several tutorials. :)

So your next step is to visit the [Troughs / Ball Drains](#) documentation which lists all the options (with pictures), as well as links to step-by-step guides which walk you through the setup of the particular type of trough or ball drain you have in your machine.

3. Enable debugging so you can see cool stuff in the log

Once you have your trough or drain device (or devices, in some cases) set up, add one more setting to that device:

```
debug: yes
```

This setting causes MPF to write detailed debugging information about this ball device to the log file. You have to run MPF with the `-v` (verbose) option to see this.

This will come in handy in the future as you're trying to debug things, and it's nice because you can just turn on debugging for the things you're troubleshooting at that moment which helps keep the debug log from filling up with too much gunk.

For example, if you have a modern style trough with a jam switch, you'd add the debug setting like this:

```
ball_devices:
  bd_trough:
    ball_switches: s_trough1, s_trough2, s_trough3, s_trough4, s_trough5, s_trough6, s_trough_jam
    eject_coil: c_trough_eject
    tags: trough, home, drain
    jam_switch: s_trough_jam
    eject_coil_jam_pulse: 15ms
```

4. Don't test yet

Since the trough or drain device works hand-in-hand with the plunger lane, and since we haven't set up a plunger lane yet, it's not worth testing your config at this point. We'll get the plunger lane set up in the next step.

Check out the complete config.yaml file so far

If you're following along with the example tutorial configurations, at this point there could be some significant divergence between the examples and your machine since the examples are based on a Demolition Man machine with a modern opto-based trough.

We still have the examples which you can try, and they'll work fine because they use the "virtual" platform which doesn't connect to real hardware. So you can run them and follow along, but just be aware that they might not match your own files exactly.

The complete machine config is in the `mpf-examples/tutorial` folder with the name `step7.yaml`.

You can run this file directly by switching to that folder and then running the following command:

```
C:\mpf-examples\tutorial>mpf both -c step7
```


Tutorial step 8: Add your plunger lane

In this step we're going to create your *plunger lane* (or *shooter lane* or *ball launcher* or *catapult* or whatever you want to call it).

This is the device that holds the ball after it's been ejected from the trough or drain where it sits waiting for the player to put it into play.

It's important to understand that a ball device is *anything that holds a ball*, even if that's just a divot in the wood with no switch where the ball sits waiting for the player to pull back on a spring plunger.

MPF's ball tracking only works if MPF knows where all the balls are at all times, which is why it needs to "know" about the plunger lane, and you let MPF know about a plunger lane by configuring it as another ball device.

1. Add your plunger/catapult/launcher/etc.

Like the trough, there are several different plunger designs. Some are purely mechanical, some launch the ball with a button which fires a coil, and some have both options. Also, some plunger lanes have a switch which the ball sits on while it's waiting to be plunged, and others don't.

Visit the [Plungers & Ball Launch Devices](#) documentation for pictures that show each option and step-by-step guides which walk you through configuring each type for MPF.

2. Revisit your trough/drain device

Even though this is mentioned in the how-to guides, once you have your plunger device set up, be sure to go back to your trough or ball drain device and add the new plunger lane as an eject target, like this:

```
eject_targets: bd_plunger
```

Of course you'd add the name that you gave your plunger device, which could be something like "bd_catapult" or whatever you called it.

Also, if you have a two-stage drain (like a System 11 machine), you'd add this to the second device (the one that feeds the plunger).

Check out the complete config.yaml file so far

Again, our example config will probably diverge from yours since you might have different types of drain and plunger devices, but we do have a complete machine conform for Demolition Man for this step which you can view in the `mpf-examples/tutorial` folder with the name `step8.yaml`.

You can run this file directly by switching to that folder and then running the following command:

```
C:\mpf-examples\tutorial>mpf both -c step8
```


4. Fire up your game and test

Unfortunately there are a few more things we need to configure before you can play a full game, but if you want to test what you have so far, you can launch MPF and drop a ball into your trough and you should see some cool things in your log file. To do this, launch the MPF game engine with the `-v` command line options so it shows the verbose information in the log file, like this:

```
C:\pinball\your_machine>mpf -vb
```

You don't have to launch the media controller this time since we're just looking at the console output of the MPF game engine, which is why we added the `b` command line option too. (The `b` option tells the MPF game engine not to use the BCP protocol and not to try to connect to the MC.)

Once your game is running, drop a ball into your trough and you should see a whole bunch of trough switches changing between active (State: 1) and inactive (State: 0).

If you don't have a physical machine, you can run MPF with the `-v` option and see a bunch of stuff in the log too by hitting the keyboard keys for the trough switches which will add and remove balls.

Now quit MPF and open the MPF log file (which is in your machine's `/logs` folder). Grab the latest file with "mpf" in the name (if you ran `mpf` both then you'll have separate log files from MPF and the MC).

Search (or filter) the log for the name of your trough or drain device, and you should see all sorts of interesting things. Here's a small snippet:

```
2016-11-18 03:54:06,103 : DEBUG : ball_device.bd_trough : Counting balls by checking switches
2016-11-18 03:54:06,103 : DEBUG : ball_device.bd_trough : Confirmed active switch: s_trough1
2016-11-18 03:54:06,103 : DEBUG : ball_device.bd_trough : Confirmed active switch: s_trough2
2016-11-18 03:54:06,103 : DEBUG : ball_device.bd_trough : Confirmed active switch: s_trough3
2016-11-18 03:54:06,103 : DEBUG : ball_device.bd_trough : Confirmed active switch: s_trough4
2016-11-18 03:54:06,103 : DEBUG : ball_device.bd_trough : Confirmed active switch: s_trough5
2016-11-18 03:54:06,103 : DEBUG : ball_device.bd_trough : Confirmed inactive switch: s_trough_jam
2016-11-18 03:54:06,103 : DEBUG : ball_device.bd_trough : Counted 5 balls
2016-11-18 03:54:06,103 : DEBUG : ball_device.bd_trough : Switching to state idle
```

What if it doesn't work?

If you've gotten this far and your trough, drain, and/or plunger isn't working right, there are a few things you can try:

If your log file shows a number of balls contained in one of your devices doesn't match how many balls you actually have, that could be:

- You didn't add all the ball switches to the `ball_switches:` section of the device's config.
- Your trough uses opto switches but you didn't add `type: NC` to each switch's configuration.
- A switch isn't adjusted properly so the ball is not actually activating it. (Seriously, we can't tell you how many times that's happened! We've also found that on some machines, if you only have one ball in the trough that the single ball isn't heavy enough to roll over the top of the eject coil shaft. In that case we just add a few more balls to the machine and it seems to take care of it.) Either way, if you have a ball in the trough, the switch entry in your log should show that the switch is active (`State:1`), like this:

```
2014-10-27 20:05:29,891 : SwitchController : <<<<< switch: trough1, State:1 >>>>>
```


If you see State:1 immediately followed by another entry with State:0, that means the ball isn't activating the switch even though it might be in the trough.

If you get a YAML error, a "KeyError", or some other weird MPF error, make sure that all the switch and coil names you added to your ball device configs exactly match the switch and coil names in the switches: and coils: sections of the machine config.

Also make sure that all your names are allowable names, meaning they are only letters, numbers, and the underscore, and that none of your names start with a number.

Finally, make sure your YAML file is formatted properly, with spaces (not tabs) and that you have no space to the left of your colons and that you do have a space to the right of your colons. At this point your trough is ready to go! Next we have to configure your plunger lane.

Tutorial step 9. Add the start button

Obviously in order to play an actual game, you have to be able to start a game, and that requires a start button. So let's add that now.

1. Add a switch for your Start button

First, add the switch for your start button to the switches: section of your config file. Again this should be easy by now. In this tutorial we'll just call this button s_start and add it like this:

```
s_start:
  number: 10
```

2. Add a "start" tag to your Start button

Just like the special-purpose tags we used when configuring the ball devices, MPF uses some special purpose tags for switches, too. One of them is start, as MPF watches for switches tagged with "start" to start games and add players to running games.

Sometimes people ask "Why do you use a tag for this? Why not just look for a switch named "start?" Again, we want MPF to be as flexible as possible, and we feel that game builders should be able to name their switches whatever they want. (Some want to preface with s_, others might not, etc.) So we use a "start" tag behind the scenes to make whatever switch you want act as the start button. So now your start switch in your switches: section should look like this:

```
s_start:
  number: 11
  tags: start
```

3. Add keyboard entries for your start switch

If you're keeping your keyboard shortcuts up to date, you can create a keyboard entry for your start switch. This is especially helpful if you're building a custom machine from scratch and you don't have a physical start button wired up yet. In that case just enter some dummy value for the number: of your start switch. Then when you run a physical machine (without the -x command line option), you can start the game with your computer keyboard but actually play it on physical hardware. For your start

button keyboard key, how about using the S key? To do so, add an entry like this to the keyboard: section of your config file:

```
s:
    switch: s_start
```

4. Add at least one playfield switch

Another thing you need to do is to configure at least one playfield switch. Why? Because when a ball is launched from your plunger onto the playfield, MPF “confirms” that the ball actually made it onto the playfield when a playfield switch is activated. How do you configure a switch as a playfield switch? You use tags, by adding a `playfield_active` tag to a switch.

At this point you might be wondering, “Wait, I thought the `eject timeouts` for the plunger was used to let MPF know when a ball really made it out of the plunger?” That’s true, and technically at this point you don’t need a playfield switch. However you’ll eventually tag all your playfield switches with `playfield_active`, so we’re just getting starting on this now. To do this, create a new entry in your `switches:` section for one of your playfield switches, for example:

```
s_right_inlane:
    number: 12
    tags: playfield_active
```

While you’re at it, create a keyboard key mapping for this switch in the keyboard: section of your config, like this:

```
q:
    switch: s_right_inlane
```

If you want you can go ahead and add entries for all your playfield switches, though that will take awhile. For now just make sure you have at least one, and make sure the ball hits that switch after it launches from the plunger before it drains. (There are lots of options for what you can do if a ball drains before it hits a switch, but we’re not going to go into those now.)

If you do decide to add all your playfield switches now, you’ll want to add the *playfield_active* tag to all the switches that might be hit by a ball being loose on the playfield. (So lane switches, ramp switches, rollovers, standups, drop targets, etc.) You do *not* want to tag ball device switches with `playfield_active` since if a ball is in a ball device, then it’s not loose on the playfield.

At this point we’re really, really close! There are a few more quick things we want to do, then run some checks. But then we’re ready to play a real game!

Check out the complete config.yaml file so far

If you want to see a complete `config.yaml` file up to this point, it’s in the `mpf-examples/tutorial` folder with the name `step9.yaml`.

You can run this file directly by switching to that folder and then running the following command:

```
C:\mpf-examples\tutorial>mpf both -c step9
```


Tutorial step 10: Run a real game

Holy Moly! It's actually time to run your first real game with MPF. When we say a "real" game, we're talking about with multiple players and balls machine flow from attract to game mode and back to attract once the game is over.

1. Make one quick addition to your display configuration

We know that at this point, you just want to run your game. The problem is if we run it now, the display will continue to show "ATTRACT MODE" throughout the entire game since we haven't configured it for anything else. So let's make a quick addition to the `slide_player:` section of your config so it will show the player and ball number when a game is in progress. (Later in this tutorial we'll revisit this and explain what's actually going on. For now just make this change.) In your config file, add a `ball_started:` entry with the following information. Your complete `slide_player:` section should now look like this:

```
slide_player:
  init_done: welcome_slide
  mode_attract_started: attract_started
  ball_started:
    widgets:
      type: text
      text: PLAYER (number) BALL (ball)
```

2. Change your flipper config so they don't automatically enable on machine boot

Almost there! The other quick change we need to make is to remove the `enable_events: machine_reset_phase_3` line from each of your flipper configuration that we added back in the *Get Flipping!* step.

This is because by default, MPF will automatically enable your flippers when a ball starts and disable them when a ball ends. But since we added a configuration setting to your flippers that set them to automatically enable themselves immediately when MPF loaded, that setting overwrote the default setting which enables your flippers when a ball starts. So as your config file is now, the flippers enable when MPF boots, then they disable when the first ball ends, and that's it. They won't enable again for Ball 2.

To make this change, simply remove the `enable_events: machine_reset_phase_3` line from each of your two flipper sections of your config file. So now your `flippers:` section should look like this: (It might not be 100% identical since you might have single-wound flipper coils and/or EOS switches.)

```
flippers:
  left_flipper:
    main_coil: c_flipper_left_main
    hold_coil: c_flipper_left_hold
    activation_switch: s_left_flipper
  right_flipper:
    main_coil: c_flipper_right_main
    hold_coil: c_flipper_right_hold
    activation_switch: s_right_flipper
```


3. Running your game with physical hardware

If you have a physical machine attached, go ahead and run your game without the `-x` or `-X` command line options. (If you don't have a physical machine and you want to simulate a game using the keyboard keys, skip to Step 4 below.)

```
C:\pinball\your_machine>mpf both -v
```

Make sure you have at least one ball in the trough and then run your game. The display should display "ATTRACT MODE." Hit the start button. A ball should be kicked out of the trough and into the plunger lane, and the display should change to "PLAYER 1 BALL 1." If you have a coil-fired plunger, you should be able to hit the launch button and the coil should fire. If you have a manual plunger, you should be able to plunge and flip. If you hit the start button a second time during Ball 1, a second player should be added. (The display won't show this since we haven't configured it to show a message, but you can see this in the logs and when the ball drains then it should go to Player 2 Ball 1 instead of Player 1 Ball 2.)

A few caveats to this early bare-bones game:

- Since you haven't configured any scoring yet, this game will be boring and nothing will score. But hey, you're playing!
- If your flippers, trough eject, or plunger coil is too weak or too strong, you can adjust them in the coil's `pulse_ms` setting in the config file.
- If you start MPF with a ball in the plunger lane and you have a coil-fired plunger, MPF will immediately fire the plunger to kick out the ball. This is by design since you don't have a "home" tag in your plunger ball device's configuration, which means that MPF will automatically eject the ball to get all the balls into ball devices tagged with "home."
- If you shoot a ball into a playfield lock or any other ball device, it will get stuck there since you haven't configured that device. (In this case you need to add configuration entries for those ball devices so MPF can know about them. Then it will automatically kick out any balls that enter. We'll get to that later.)
- By default MPF is configured to allow a maximum of 4 players per game, with 3 balls per game. You can change this in the `game` section of the machine config.

4. "Playing" a game without a physical machine attached

If you've been adding keyboard switch map entries to your config file as you've been going through this tutorial, you can actually "play" a complete game on your computer keyboard. Here's how you do it:

1. Launch the MPF game engine and the MC. Note that in order for this to work, we want to use the "smart virtual" platform. This will be the default, but make sure you do not have `platform: virtual` in your config. (If you do have a platform entry in your config, make sure it's `platform: smart_virtual`.) If you have a different platform setting for your physical hardware, you can still run without the hardware connected by using the `-X` (uppercase X) command line option to specify the smart virtual platform interface.
2. Push the "S" key to start a game. At this point MPF will eject a ball from the trough to the plunger
3. If you have a coil-fired plunger, push the "L" key (or whatever key you mapped to your launch button) to launch the ball.

4. If you do not have a coil-fired plunger, push the “P” key (or whatever key you mapped to your plunger lane switch) to un-toggle that switch which simulates the ball leaving the plunger lane.
5. Now you can “flip” with the “Z” and “?” keys.
6. After you get bored of this, push the “1” key to activate a trough ball switch. At this point MPF will think a ball drained and you should see the display switch to Ball 2 and the trough switch should open and the plunger lane switch should close as the “smart virtual” platform ejects a ball from the trough to the plunger.
7. Repeat until you’re bored.
8. After Ball 3 is over the display will change back to the “ATTRACT MODE” text and you can push “S” again to start another game.
9. Congrats! You just played your first virtual pinball game. Yeah, it’s boring, but you did it!

5. What if your game won’t start?

If your game doesn’t start or doesn’t work, hopefully we’ve given you enough information in this tutorial to work out what the problem is. That said, here’s a list of things that could go wrong:

- No ball in the trough.
- Ball in the trough, but not activating the switch.
- Trough switches are optos but you didn’t add type: NC to your switch configurations. (Mechanical trough switches do not need a type: setting.)
- Trough is trying to eject, but the trough coil’s pulse_ms: setting is too weak and the ball can’t get out.
- Incorrect switch or coil numbers which don’t match up to your actual hardware inputs and outputs.
- Some other setting isn’t configured properly, which could lead to who-knows-what error? (Maybe compare your config file to the complete config from mpf-examples?)

If you’re still having problems, feel free to post to the mpf-users Google group.

Check out the complete config.yaml file so far

If you want to see a complete config.yaml file up to this point, it’s in the mpf-examples/tutorial folder with the name step10.yaml.

You can run this file directly by switching to that folder and then running the following command:

```
C:\mpf-examples\tutorial>mpf both -c step10
```

Remember though that unless you’re following this tutorial with an actual *Demolition Man*, you’ll have some differences in your config file.

Tutorial step 11: Add the rest of your coils and switches

Okay, so at this point you have a working game. The biggest problem you might run into is that if you shoot your ball into a playfield device like a VUK or popper, the ball will get stuck. Why? Because you

haven't yet added the switches to your config file while let MPF know that a ball is there, and you haven't added the coils which MPF needs to fire to eject a ball. So MPF literally has no idea that those switches and coils even exist, which means it has no ability to detect a ball entering a device and to eject it. So when we're building a config for a new game, at this point we go through our config and add all the remaining switches and coils to `and switches:` and `coils:` sections of the config file.

1. Add the rest of your switches

This step is pretty simple. If you building a config for an existing machine, we usually use the operators manual as our starting point and just move down the list and add all the switches as they're listed in there. We don't worry about tags at this point *except for* `playfield_active` tag. We add this tag to any switch the ball can hit when it's active and rolling around on the playfield. (So this is going to be your lanes, slingshots, pop bumpers, ramp entry & exit switches, rollovers, stand up targets, drop targets, and anything else the ball can hit when it's in motion. The tricky thing is that you do not add a `playfield_active` tag to switches in other ball devices. For example, if you have a hole in the playfield that the ball rolls into which requires a coil pulse to kick it out of—that is not a playfield switch (since when the ball is in that hole, it's not actively rolling around the playfield). We'll actually set that switch up as a part of a ball device in a later step.

2. Add the rest of your coils

Next add entries for the rest of your coils, again using the operators manual as a guide if you're building a config for an existing machine. You don't have to worry about pulse times at this point—just get the coils added.

Check out the complete config.yaml file so far

If you want to see a complete `config.yaml` file up to this point, it's in the `mpf-examples/tutorial` folder with the name `step11.yaml`.

You can run this file directly by switching to that folder and then running the following command:

```
C:\mpf-examples\tutorial>mpf both -c step11
```

Note that starting with this step, the actual coil, switch, and ball `device` names don't 100% match with what we have in the tutorial. This shows you that there are lots of different options when it comes to naming things.

Tutorial step 12: Add the rest of your ball devices

Now that you've added all your switches and coils, you'll probably notice that the ball is *still* getting stuck in devices on the playfield when it enters them. This is because MPF doesn't know that certain switches and coils are associated with ball devices, so MPF doesn't know that it should fire a coil when a certain switch becomes active. So the next step is to create configuration entries for the rest of your ball devices.

The good news is that once you do this, a ball entering a device will automatically be ejected, so when you're done with this step, your ball shouldn't get stuck anywhere.

To do this, take a look at all the ball devices around your playfield and then create entries for each one in the *ball_devices:* section of your config file. Depending on your machine, you might have 5 or 6 of these. (Ball devices are anything where the ball could go where it's held and not actively rolling around on the playfield.) At a bare minimum, you need to add *ball_switches:*, *eject_coil:*, and *eject_timeouts:* settings for each ball device you add. The *eject_timeouts:* entry is critical, because if a ball ejects to the playfield but then doesn't hit a switch right away, this is the how long MPF will wait before assuming the ball made it out of the device successfully. (Again, set this timeout to be the longest amount of time that could pass with a ball failing to eject and falling back in.) Simple playfield kickouts might be fine with 500ms or 750ms, and VUKs might be around 2 or 3 seconds.

After you add all your ball devices, you should be able to play a game without the ball getting stuck anywhere! (And if you start MPF with balls already stuck in devices, MPF will automatically eject the balls when it boots because these additional devices do not have "home" listed as one of their tags.) Here's the *ball_devices:* section from a *Demolition Man* config file:

```
ball_devices:
  bd_trough:
    tags: trough, home, drain
    ball_switches: s_trough1, s_trough2, s_trough3, s_trough4, s_trough5, s_trough_jam
    eject_coil: c_trough_eject
    entrance_count_delay: 300ms
    jam_switch: s_trough_jam
    eject_targets: bd_plunger
    debug: yes

  bd_plunger:
    ball_switches: s_plunger_lane
    entrance_count_delay: 300ms
    eject_timeouts: 3s
    tags: ball_add_live
    eject_coil: c_plunger_eject
    player_controlled_eject_event: sw_launch

  bd_retina_hole:
    ball_switches: s_eject
    eject_coil: c_retina_eject
    eject_timeouts: 1s

  bd_lower_vuk:
    ball_switches: s_bottom_popper
    eject_coil: c_bottom_popper
    eject_timeouts: 2s

  bd_upper_vuk:
    ball_switches: s_top_popper
    eject_coil: c_top_popper
    eject_timeouts: 2s

  bd_elevator:
    ball_switches: s_elevator_hold
    mechanical_eject: true
    eject_timeouts: 500ms
```

Remember that if you need to adjust the eject coil pulse time, you do that in the coil's property in the *coils:* section of your config file, not in the ball device configuration.

Check out the complete config.yaml file so far

If you want to see a complete config.yaml file up to this point, it’s in the mpf-examples/tutorial folder with the name step12.yaml.

You can run this file directly by switching to that folder and then running the following command:

```
C:\mpf-examples\tutorial>mpf both -c step12
```

Tutorial step 13: Add slingshots, pop bumpers, and other “autofire” devices

While we’re setting up the basic playfield devices, let’s configure the “autofire” devices like slingshots and pop bumpers. (An “autofire device” is anything where you have one switch and one coil and the switch being hit automatically causes the coil to fire.) This makes the game more fun since it’s kind of sad to see a ball hit a slingshot and nothing happen. You add these autofire devices in the autofire_coils: section of your machine configuration. It’s pretty simple. Just create an entry for the name you’d like to give that device, and then add sub-entries for the switch: and coil: for that device. For example, here’s the autofire_coils: configuration for *Demolition Man*, which has two standard slingshots, and upper slingshot near the pop bumpers, and two pop bumpers (which we happen to refer to as “jets” in this config):

```
autofire_coils:
  left_slingshot:
    coil: c_left_slingshot
    switch: s_left_slingshot
  right_slingshot:
    coil: c_right_slingshot
    switch: s_right_slingshot
  upper_slingshot:
    coil: c_top_slingshot
    switch: s_top_slingshot
  left_jet:
    coil: c_left_jet_bumper
    switch: s_left_jet
  right_jet:
    coil: c_right_jet_bumper
    switch: s_right_jet
```

Autofire devices in MPF are somewhat intelligent. They will only be activated while a ball is in play during a game, which means they automatically deactivate themselves during attract mode and if the player tilts. (You can override these default settings as well as configure additional MPF events that will cause them to activate or deactivate. See the [autofire_coils](#): section of the configuration file reference for details, though you don’t have to do that now.)

Remember if you want to adjust the strength of these coils, you can do that in the coil’s pulse_ms: setting in the coils: section of your config.

Check out the complete config.yaml file so far

If you want to see a complete config.yaml file up to this point, it’s in the mpf-examples/tutorial folder with the name step13.yaml.

You can run this file directly by switching to that folder and then running the following command:

```
C:\mpf-examples\tutorial>mpf both -c step13
```

Tutorial step 14: Add your first game mode

By this point in the tutorial you should have a “playable” game, though it’s pretty boring because there’s no scoring, no modes, and the display just shows *PLAYER X BALL X* the whole time.

So in this step the real fun will begin as we configure our first game mode! So far all of the configuration you’ve been doing has been machine-wide configuration which was stored in the `/config` folder in your game’s machine folder.

All of the configuration options you added to the `config.yaml` applied machine-wide.

In this step, we’re going to add a `/modes` folder to your machine folder. Then we’ll add a subfolder for each game mode, and in each we’ll create a YAML config file that controls what happens in that specific mode.

What’s cool about MPF’s modes system is that all of the configuration you do for a mode is only active when that mode is active. In fact from here on out, almost everything you configure will be at the *mode-level* rather than the *machine-wide* level. As we go deeper into the tutorial and the How To guides, you’ll start to get a feel for what types of things should be in the machine-wide configuration versus the types of things that should be in mode-specific configurations. Pretty much all the hardware (coils, switches, lights, leds, ball devices, platform, DMD, etc.) are configured as machine-wide settings, and then game logic-type things (scoring, shots, sound effects, animations, light shows, etc.) are configured as mode-specific settings.

MPF can have as many modes running at once as you want. In fact you’ll probably use this to your advantage, breaking up your game into lots of little modes to make the programming easier. (Many of these modes will not be “in your face” modes that the player is aware of. Things like skill shot, combo timers, super jet counters, etc., will all be configured as modes even though the player wouldn’t think of them as modes.)

1. Read the documentation about modes

The first step to setting up a game mode is to understand how game modes work in MPF. So read [that documentation now](#) to get an overview, and then come back here for the step-by-step walk-through of doing your first mode.

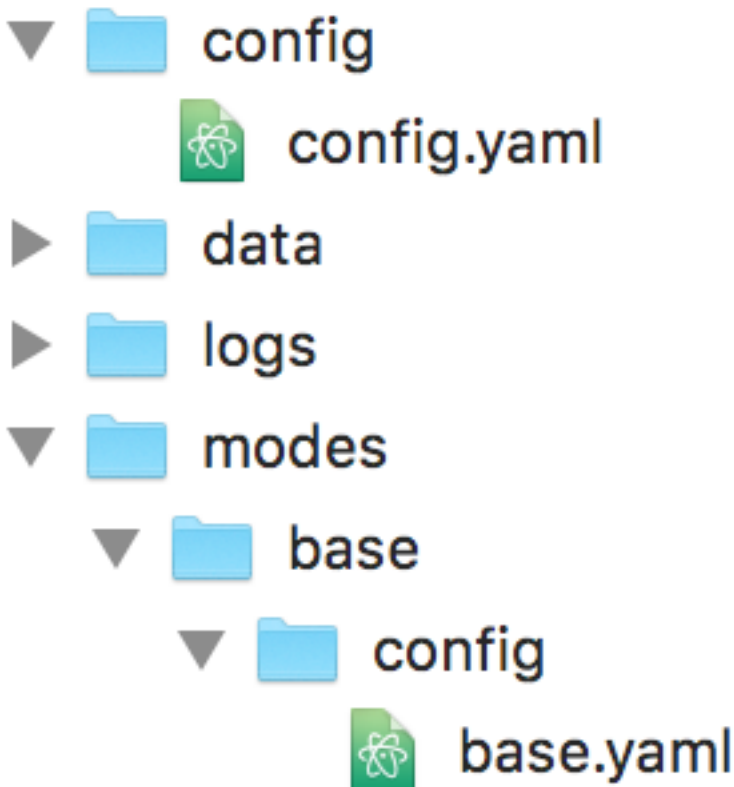
2. Set up the folders & files for your “base” mode

The first mode we’re going to create is a mode called “base.” (Don’t call it “game” because MPF has a built in mode called “game” that you don’t want to overwrite.) This “base” mode will be running at all times while a game is in play and can be thought of as the “default” game mode. We’ll set up default shots, scoring, configure the display to show the score, etc. Everything in the base game mode will be available if no other higher-priority modes are running. To create the base game mode:

1. Create a folder called `modes` in your machine’s folder.
2. Create a subfolder your modes folder called `base`. (You will ultimately create one subfolder for each mode you have, and the name of the folder controls the name of the mode.)

3. Inside your base folder, create a folder called `config`. (This folder will hold your mode-specific config files.)
4. Inside your config folder, create a file called `base.yaml`. (This is the default config file for your base mode. We use the naming scheme `<mode_name>.yaml` instead of `config.yaml` for these to make it easier to keep track of which files are which if you open a bunch of them at once in your editor.)

At this point your machine's folder & file structure should look like this:



3. Add your base game mode's settings to its config file

The settings that control a mode are configured the mode's own configuration file. We do this because it allows modes to be completely self-contained. In other words, as long as you have a mode's folder and all its content, then you have everything you need for that mode.

So let's configure some settings for the base mode in the base mode's config file. To do this, open your new mode's `base.yaml` in your code editor. Add the `config_version`, then create a top-level configuration section called `mode:`. On the next line, indent four spaces and add the entry `start_events: ball_starting`. On the following line, also indent four spaces and type `priority: 100`. Your `base.yaml` file should now look like this:

```
#config_version=4
mode:
    start_events: ball_starting
    priority: 100
```


There are lots more settings besides `start_events` and `priority` which you can set for a mode. See the [mode](#): for details.

The two settings we added here should be pretty obvious. The `start_events: ball_starting` means that this mode will automatically start when the MPF event `ball_starting` is posted. (In other words, this mode will start whenever a ball starts.) You can also enter a list of `stop_events` to control how the mode ends, though if you don't enter one here then the mode will automatically stop when the ball ends, so you don't have to specify a stop event now.

The `priority: 100` means that everything this mode does will have a base priority of 100. We'll create future modes at higher priorities so they can take over the display, control lights, filter and block scoring, etc. (You read the [documentation about modes](#), right?)

Also, when you create your own modes, keep them between 100 and 1,000,000. MPF has some built-in modes above and below those values that should stay at the top and bottom of the priority stack.

4. Add your mode to your machine-wide config file

Now that you have a mode set up, you need to go back to your machine-wide configuration file to add this new mode to the list of modes that your game will use. At first you might think this is a bit confusing. After all, you just created a folder and a config file for your new mode, so why do you have to specify that mode in another location too?

The reason is we don't want to automatically include a mode in a game just because that mode has a folder in the `modes` folder. (After all, what if you're testing something out, or if you have multiple versions of a mode you're playing with? It would be dangerous if MPF just automatically loaded every mode it found.)

So instead we built MPF so that you have to add all the modes you want to be available in a game to a list in the machine-wide config file. To do this, go back to your machine-wide `config.yaml` file (in `<your_machine>/config/config.yaml`) and add a top-level section called `modes:`. (Like all the sections in your config file, you can put this section anywhere you want in your file. Maybe up towards the top so it's easy to find later?) Then on the next line, type two spaces, then a dash, then another space, then type `base`. So now that section of your `config.yaml` should look like this:

```
modes:
  - base
```

Note that it's very important that you put dashes in front of each mode in this list? Why? Because with dashes, MPF will be able to combine settings together in this list from different config files.

For modes that important, because MPF has several built-in modes it uses for its own things. (For example, "attract" and "game" are both modes, and we'll be creating future ones that you might want to use too for tilt, volume control, game statistics, high score entry, credits, etc.)

5. Run your game to verify your new mode works

Be sure to save the changes to `base.yaml` and `config.yaml`, and then run your game again. For this test, you do not need to use verbose logging since mode information is reported in the basic level of logging. Once MPF is running, start a game and you should see something like on the console and/or the log file:


```
INFO : Mode.attract : Mode Starting. Priority: 10
INFO : SwitchController : <<<<< switch: s_start, State:1 >>>>>
INFO : SwitchController : <<<<< switch: s_start, State:0 >>>>>
INFO : Mode.game : Mode Starting. Priority: 20
INFO : Mode.game : Player added successfully. Total players: 1
INFO : Mode.base : Mode Starting. Priority: 100
INFO : SwitchController : <<<<< switch: s_trough_1, State:0 >>>>>
INFO : SwitchController : <<<<< switch: s_shooter_lane, State:1 >>>>>
INFO : SwitchController : <<<<< switch: s_shooter_lane, State:0 >>>>>
```

6. Make your base mode do something useful

We already mentioned that there are lots of different things you could add to your base mode. For now, let's configure the display so that it shows the player's score, as well as which player is up and what ball it is, like this:



To do this, go back to your base mode's config file (<your_machine>/modes/base/config/base.yaml) and add a section called `slide_player:`. Then add the following subsections so your complete `base.yaml` looks like this:


```
#config_version=4
mode:
    start_events: ball_starting
    priority: 100

slide_player:
    mode_base_started:
        widgets:
            - type: text
              text: (score)
              number_grouping: true
              min_digits: 2
              font_size: 100
            - type: text
              text: PLAYER (number)
              y: 10
              x: 10
              font_size: 50
              anchor_x: left
              anchor_y: bottom
            - type: text
              text: BALL (ball)
              y: 10
              x: right-10
              anchor_x: right
              anchor_y: bottom
              font_size: 50
```

We briefly touched on the `slide_player:` functionality earlier in this tutorial and how you can configure it to show certain slides when various MPF events happen.

Every time a mode starts in MPF, an event called `mode_(name)_started` is posted. So in this case, we set our slide player entry to play when it sees the event `mode_base_started` which means it will play that slide as soon as the base mode starts. (And since you configured your base mode to start based on the `ball_starting` event, this means this slide will be created and shown whenever a new ball is started.)

You may be wondering why we don't set that slide to play on the `ball_starting` event? The key to remember with game modes is that all the settings in your mode-specific config file are only active when the mode itself is active. In the case of our base mode, the `ball_starting` event is what actually causes the mode to start. When `ball_starting` is posted, the base mode starts and loads its configuration. At that point that `ball_starting` event has already happened, so if you set a slide to play within that mode then it will never play because it doesn't start watching for that event until after it happened. (Hopefully that makes sense?)

Anyway, if you look at the `slide_player:` settings, you'll see that the slide that is shown when the event `mode_base_started` is posted contains three text widget. One that shows the score, one the shows the player and one that shows the current ball number. Note that the `text:` entries for those have have some words in parentheses.

Words in parentheses signs are variables that are replaced in real time when they're updated. In this case these are "player variables" because they are values that belong to the current player. More on using dynamic text (that is, text that automatically updated itself as underlying values change), is [here](#).

Also note that there are some additional positioning settings, like `x:`, `y:`, `anchor_x:`, and `anchor_y:`.

You can read about these in our [How to position widgets on slides](#) guide.

Finally, note that the text widget showing the score has settings for `number_grouping:` and `min_digits:`. You can read about what those do in the [documentation for the text display widget](#).

6. Remove the old `slide_player: ball_started` entry

Now that you have this cool score display from your new base mode, you can go into your machine-wide `config.yaml` and remove the `slide_player: entry` for `ball_started:`. So now the `slide_player:` in your machine-wide `config.yaml` should just look like this:

```
slide_player:
  init_done: welcome_slide
  mode_attract_started: attract_started
```

What if it didn't work?

- Make sure you actually start a game. Remember that this new base mode is only active when a ball starts from a game that's in progress, so you won't see the mode until a game starts. (If you're not able to start a game, check the troubleshooting tips in the previous step.)
- If you get some kind of crash or error, specifically any errors that mention anything about "config" or "path," double-check that you put all the files in the proper locations back in Step 2. (A common mistake is to put `base.yaml` in the `/modes/base` folder rather than the `/modes/base/config` folder.)

Check out the complete `config.yaml` file so far

If you want to see a complete `config.yaml` file up to this point, it's in the `mpf-examples/tutorial_step_14` folder with the name `config.yaml`.

Note that this is a different folder than the previous steps. Since we now have subfolders in the machine folder, steps 14+ now each have their own folder in the `mpf-examples` folder. So switch out of the `mpf-examples/tutorial` folder and to the `mpf-examples/tutorial_step_14` folder, then run `mpf both`. (You don't need the `-c` option since we're back to using `config.yaml` instead of a custom config file name.)

```
C:\mpf-examples\tutorial_step_14>mpf both
```

Tutorial step 15: Add scoring

By now you have a "playable" game with a base game mode, and you've got a score showing on the display, but it's still pretty boring since nothing is actually configured to register a score yet. So in this step we're going to add some scoring.

1. Understand in scoring works in MPF

MPF includes a core module called the *Score Controller* which is responsible for adding (or subtracting) points from a player's score. Actually, that's not a completely accurate description. We

should really say that the score controller is responsible for adding or subtracting value from any player variable. (A player variable is just a key/value pair that is stored on a per-player basis.) The *score* is the most obvious player variable. But MPF also uses player variables to track what ball the player is on, how many extra balls the player has, etc. You can create player variables to track anything you want. Ramps made, combos made, number of modes completed, aliens destroyed, etc.

Even though it's called the *score* controller, the score controller is responsible for adding and subtracting value from any player variable based on events that happen in MPF. You configure which events add or subtract value to which player variables in the *scoring:* section of a mode's configuration file.

2. Add a *scoring:* section to your *base.yaml* mode config file

The first step is simply to add a *scoring:* section to your base mode's *base.yaml* config file. So in this case, that will be `<your_machine>/modes/base/config/base.yaml`. Add a new top level configuration item called *scoring:*, like this:

```
scoring:
```

3. Add point values for events

Then inside the *scoring:* section, you create sub-entries for MPF events that you map back to a list of player variables whose value you want to change. By default, whenever a switch is hit in MPF, it posts an event `<switch_name>_active`. (A second event called `<switch_name>_inactive` is also posted when the switch opens back up.) To give the player points when a switch is hit, add sub-entries to the *scoring:* section of your config file, with some switch name followed by `"_active"`, like this:

```
scoring:
  s_right_inlane_active:
    score: 100
  s_left_flipper_active:
    score: 1000
```

Now save your config, start a game (S), hit the L key to launch a ball, then hit the Q key to trigger the right inlane switch. You should immediately see a score of 100 points. Then if you hit the Z key for the left flipper, you'll see the player's score increase by 1000 points. You can hit it as many times as you want to see the score increase:

Remember from the previous step that the *slide_player:* section of the config contains a text widget with a value of (score) in parentheses, and any values in parentheses are updated automatically when the underlying player variable changes. So that's how the display is updating automatically here.

By the way, there's a [reference list of many built-in events](#) in the documentation, so you can browse through that to get an idea of the various types of events that exist which you can use to trigger display slides or score events.

Note that *scoring:* events in a mode's config file are only actually active when that mode is active. So the section we're adding in this step is in the base mode's config, which we've set to start any time a ball starts. But if the base mode ever wasn't running, then the `s_right_inlane_active` and `s_left_flipper_active` events wouldn't trigger a score.

When you create more modes in the future, you can actually configure that a score event in a higher-priority mode "blocks" the scoring event in a lower-priority mode. So you could have a pop

bumper that is worth 100 points in a base mode, but then you could also make it worth 5,000 points in a super jets mode while blocking the 100 point score from the base mode since if the scoring from both modes was active, you'd get two scoring events—the 100 from the base mode and the 500 from the super jets mode. (More on that later.)

Later on you can also configure *shots* which can control lights and manage sequences of switches and lots of other cool things, so that's how you can track the ball moving left-to-right or right-to-left around a loop, and from there you'll be able to configure different scoring events for each direction. (Again, we'll get to this later. For now you can just wire up scoring to a switch to see it working.)

4. Play with more player variables

As we said, you can add or subtract value from any player variable via the `scoring:` section—even player variables that you make up.

For example, try changing your scoring section to this:

```
scoring:
  s_right_inlane_active:
    score: 100
  s_left_flipper_active:
    score: 1000
    potato: 1
  s_right_flipper_active:
    potato: -2
```

We use the word “potato” here to illustrate that player variables can be anything. So now when the left flipper is active, the player variable called “score” will increase by 1000, and the player variable called “potato” will increase by one. (If you make a reference to a player variable that hasn't been defined before, it will automatically be created with a value of 0.)

Also notice that when the right flipper is hit, the player variable called “potato” will have a value of 2 subtracted from it.

Player variables exist and are tracked even if they're not displayed anywhere. So if you run your game now and start flipping, the potato value will change. Again, player variables are stored on a per-player basis, so if you start add additional players to the game, they'll each have their own copies of their own player variables. Also the player variables are destroyed when the game ends. (It is possible to save certain variables from game-to-game, but we'll discuss those later, as those are not player variables.)

So now that we're tracking this potato variable, let's add it to the display. To do this, let's add another widget to the slide that is show when the base mode starts. (So we're going to be editing `<your_machine>/modes/config/base.yaml` again. Add the potato text entry, like this:

```
slide_player:
  mode_base_started:
    widgets:
      - type: text
        text: (score)
        number_grouping: true
        min_digits: 2
        font_size: 100
      - type: text
        text: PLAYER (number)
        y: 10
```



```
x: 10
font_size: 50
anchor_x: left
anchor_y: bottom
- type: text
  text: BALL (ball)
  y: 10
  x: right-10
  anchor_x: right
  anchor_y: bottom
  font_size: 50
- type: text
  text: "POTATO VALUE: (potato)"
  y: 40%
```

Notice that we put `text: "POTATO VALUE: (potato)"` in quotes. That's because we actually want to show the colon as part of the text that's displayed on the screen. However colons are important in YAML files. So if we made our entry like this: `text: POTATO VALUE: (potato)`, then we would get a YAML processing error because the YAML processor would freak out. "OH MY THERE ARE TWO COLONS?? WHAT'S THIS MEAN???" <crash>

So we use quotes to tell it that the second colon is just part of our string.

Now you can run your game (via `mpf both`), S to start a game, L to launch a ball, then use the Z and / keys to left and right flip which will adjust the potato value accordingly.

Notice that when you first start a game, the onscreen text says `POTATO VALUE: (potato)`. That's because when this slide is first displayed, there is no player variable called "potato"—it's not created until you hit a flipper button—so the text widget doesn't know what to do with "potato", so it just prints it as is. Later we'll learn how to properly initialize variables, but the main thing for now is to see how the scoring and slide player works.

Check out the complete config.yaml file so far

If you want to see a complete `config.yaml` file up to this point, it's in the `mpf-examples/tutorial_step_15` folder with the name `config.yaml`. You can run it by switching to that folder and running `mpf both`:

```
C:\mpf-examples\tutorial_step_15>mpf both
```

Tutorial step 16: Create an attract mode display show

Now that we have a running game and some basic scoring, let's continue to make the display more useful by creating a slide show that plays during the attract mode and cycles through a few different slides. ("GAME OVER", "PRESS START", ... that sort of thing.)

1. Create an attract mode folder structure

So far it looks like your game only has one mode. (The *base* mode you created a few steps ago.) But MPF actually has a few built-in modes that it uses to do its thing. For example, there's a mode called

“attract” which runs the attract mode (including watching for the start button press to start a game), and there’s a mode called “game” which actually runs your games. (You may have noticed these modes in your logs. *Attract* runs at priority 10 and *game* runs at priority 20.)

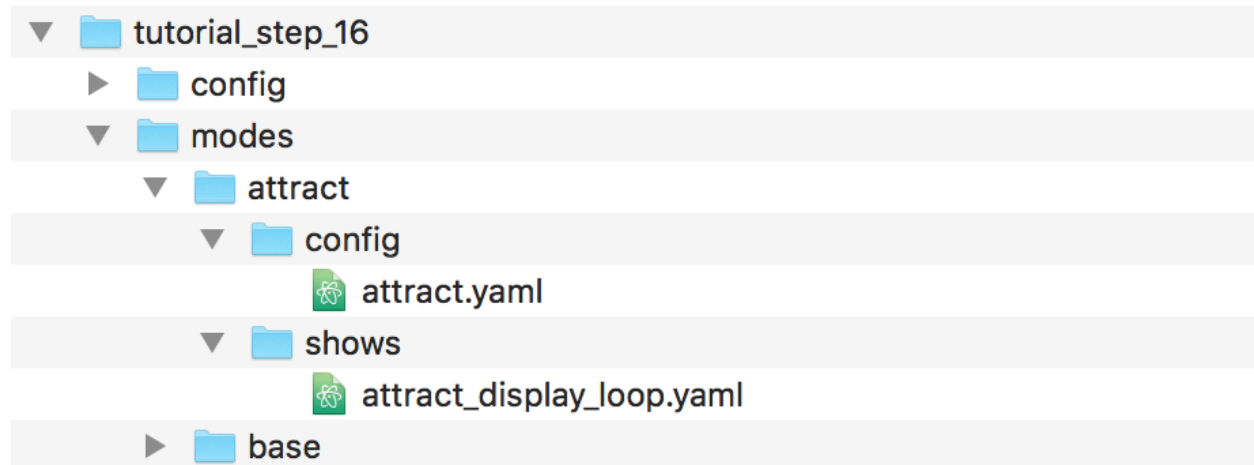
Even though the attract mode is built-in, you can still create an attract mode folder and an attract mode config which enable you to extend the attract mode for your own use. So let’s do that now.

Go into your machine’s /modes folder (which should only have your base folder in it) and create a new folder called attract. Now you should see two folders in it:

Now create a /config folder in your attract folder, and then create a new config file called attract.yaml. So the attract folder is pretty much just like the base folder, with the file attract.yaml used to control the settings that will be used when the attract mode is active.

Finally, create a folder called /shows in your new attract mode folder, and inside that folder, create a new file called attract_display_loop.yaml.

Your new machine folder structure should look like this:



2. Edit your show yaml file

MPF has the ability to run “shows” which are coordinated series of lights, sounds, slides, flashers, images, videos, etc. These show files also use the .yaml file format, though they’re different than the yaml config files. You can name the show whatever you want. In this case we called it attract_display_loop.yaml since that pretty much describes what it does.

Note that we put this show file in a folder called “shows” in our attract mode folder. Technically you can play any show from any mode (and you could add a machine-wide /shows folder if you want), but we prefer to add the shows used by a mode inside that mode’s /shows folder since it keeps everything from one mode together.

Here’s a complete sample attract_display_loop.yaml file you can use as a starting point:

```
#show_version=4

- duration: 3s
  slides:
    awesome_slide:
      widgets:
        - type: text
```



```

    text: YOU ARE AWESOME
    font_size: 50
  transition:
    type: push
    duration: 1s
    direction: left
- duration: 3s
  slides:
    press_start:
      widgets:
        - type: Text
          text: PRESS START
      animations:
        pre_show_slide:
          - property: opacity
            value: 0
            duration: .5s
          - property: opacity
            value: 1
            duration: .5s
            repeat: -1
        - type: Text
          text: FREE PLAY
          color: green
          y: 10
          anchor_y: bottom
      transition:
        type: move_in
        duration: 1s
        direction: right
- duration: 3
  slides:
    mission_pinball:
      widgets:
        - type: Text
          text: MISSION PINBALL
          color: red
      transition:
        type: move_in
        duration: 1s
        direction: top

```

First, notice the first line is `#show_version=4`. This is similar to the `config_version` in config files, except since this is a show file, it's "show_version".

Next, notice that the show file is broken into steps, each beginning with a dash and then a duration: entry. The duration: entry controls how long each step is. The default value is seconds, though you can enter standard time strings like `duration: 3s` or `duration: 300ms`, etc.

By the way, when you play back a show, you can set the playback speed. So even though all the steps are 3 seconds long in our example show, when you play the show, you could (for example), set the playback speed to 2.0, and each step would be 1.5 seconds instead of 3 (since it's playing 2x as fast).

There's a whole section of documentation on [shows](#), so review that at some point for all sorts of

details about show files, formats, etc.

In addition to the `duration:` setting in each step, also notice that each step has a `slides:` setting. The format and content of the `slides:` section of a show is identical to the `slide_player:` section in a config file.

So “`slide_player:` in config file” = “`slides:` in a show”. (In the future you’ll see this applies to other “players” like `led_player:` in a config file is the same as `leds:` in a show, `sound_player:` in a config file is the same as `sounds:` in a show, etc.)

Then in the `slides:` section of each step, we’ve added a slide name. These slides are named `awesome_slide`, `press_start`, and `mission_pinball` in the example above. The slide names don’t really matter, but since none of these slides have been defined yet, we add a `widgets:` section to each one and define them here. (The slides are only created once, the first time they’re displayed. After that they are kept in memory so they can be used over and over. They’re only removed from memory when the attract mode stops.)

Also notice that we added `transition:` settings which control how one slide transitions to the next. Without transitions, the new slide appears instantly. But with transitions, we can make one slide move in from the side, or cross fade, etc.

3. Configure your show to play automatically

Now that you’ve created your show, we need to make it so it plays. In this case we want this show to play whenever the attract mode is running. To do this, go back to the config file for the attract mode (`<your_machine>/modes/attract/config/attract.yaml`) and add the following:

```
#config_version=4

show_player:
  mode_attract_started: attract_display_loop
```

Note that we don’t need a `mode:` section here because those settings are already configured in the default attract mode settings folder contained inside of MPF. So instead all we need to do is add a `show_player:` entry. Like the `slide_player:` we’ve used in the past, the `show_player:` section contains sub-sections for MPF events, and when that event is posted the shows underneath it are started.

In this case we’re going to start the show when the `mode_attract_started` event is posted.

You can also use the `show_player:` section of a config to set events that stop shows, but shows that are started from modes automatically stop when that mode stops. (The beauty of mode-based configs!) So in this case, the `attract_display_loop` will automatically stop when the attract mode stops (which it does when a game starts).

4. Remove the attract mode stuff from your machine config

One last thing you should do here while you’re at it is go back into the machine-wide config `<your_machine>/config/config.yaml` and remove the `attract_started` slide from the `slides:` section, and the `mode_attract_started` entry from your `slide_player:` section.

OLD machine-wide config (partial):

```
OLD:
slides:
```



```
welcome_slide:
  widgets:
    - type: text
      text: PINBALL!
      font_size: 50
      color: red
    - type: rectangle
      width: 240
      height: 60
  attract_started:
    widgets:
      - text: ATTRACT MODE
        type: text

slide_player:
  init_done: welcome_slide
  mode_attract_started: attract_started
```

NEW machine-wide config:

```
slides:
  welcome_slide:
    widgets:
      - type: text
        text: PINBALL!
        font_size: 50
        color: red
      - type: rectangle
        width: 240
        height: 60

slide_player:
  init_done: welcome_slide
```

The reason we remove this is because it's not necessary now that we have our new attract mode display show running.

Plus, even if you don't remove this entry, the original "ATTRACT MODE" text from the machine-wide config won't show up anymore. Why? Because the attract mode runs at Priority 10, and the machine-wide config is Priority 0. So the display show from the attract mode config will show on top of the slide from the machine-wide config, so we may as well remove the machine-wide won.

Now when you run your game via `mpf both`, you should see the attract mode display show. Then when you press Start (or the S key), everything else should proceed as it did before.

If you play through a complete game (3 balls), then when the game is over, you should see the attract mode display show start up again.

Check out the complete config.yaml file so far

If you want to see a complete config.yaml file up to this point, it's in the `mpf-examples/tutorial_step_16` folder with the name `config.yaml`. You can run it by switching to that folder and running `mpf both`:


```
C:\mpf-examples\tutorial_step_16>mpf both
```

Tutorial step 17: Add lights (or LEDs)

Now that you're able to run a complete (albeit boring) game, let's get your lights or LEDs configured and make it so they play a show while your machine is in attract mode.

If you're following this tutorial with virtual hardware, it's still worth doing this step because you can use *The MPF Monitor* to see your lights and LEDs in realtime against a picture of your playfield.

1. Understand “lights” versus “LEDs”

In MPF, “lights” refers to bulbs that are plugged into a lamp matrix, while “LEDs” refers to direct-connected LEDs (which are usually RGB).

In other words, if you have a lamp matrix, but you're using LED replacement bulbs with it, you still configure those as “lights”. See *“Lights” versus “LEDs” (Some LEDs are lights?!?)* for details.

2. Add your lights/LEDs to your machine config file

Once you figure out whether you have lights or LEDs, you need to add the relevant section to your machine configuration file. There's probably not much to explain here. Adding lights and LEDs is pretty similar to adding switches and coils.

See the relevant documentation for each for instructions how to enter them:

- *Lights*
- *LEDs*

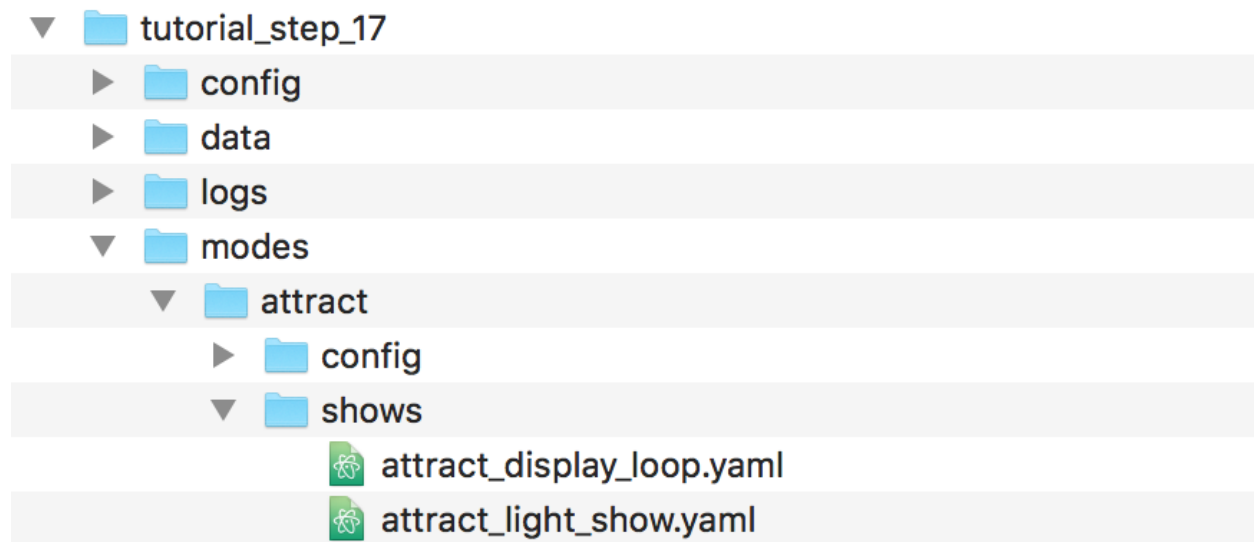
3: Create an attract mode light/LED show

Once you add your lights or LEDs, you need a simple way to test them to make sure they're working. We typically throw together a quick attract mode light show so we can see some blinking lights as soon as MPF boots up.

The easiest way to create a complex series of light actions is with MPF's *show* functionality. This is the exact same type of show that we use for the display loop, except this time we configure lights or LEDs for each step instead of slides.

Show entries for lights and LEDs are very similar, except with LEDs you specify full RGB values whereas with lights you just specify whether they're on or off.

So the first thing to do is to create another show file in your attract mode shows folders. Let's call this one `attract_light_show.yaml`. Your attract mode shows should now look like this:



Note that we started both of these file names with the word “attract”. That is certainly not required and you can name them whatever you want. We find it’s a bit easier to add the mode name so we can know which files are which when we have a bunch of files open in the editor at the same time.

4. Add some entries to your show

There are all sorts of things you can do with a light show file that you’ll become familiar with as you get deeper into your game configuration. For now we’re just going to create a simple show that cycles through three lights. We’ll call them *light1*, *light2*, and *light3*, though there’s a good chance that you don’t have lights with those names in your machine so you’ll have to change them to names that actually exist for you. If you have matrix lights, add entries to your `attract_light_show.yaml` file so that it looks something like this:

```
#show_version=4
- duration: 1
  lights:
    l_light2: 0
    l_light1: ff
- duration: 1
  lights:
    l_light1: 0
    l_light2: ff
- duration: 1
  lights:
    l_light2: 0
    l_light3: ff
- duration: 1
  lights:
    l_light3: 0
    l_light2: ff
```

Matrix lights don’t have color setting since their color is determined by the color of the bulb and/or the color of the insert. So the 0 and ff values here just represent “off” (0) and “on” (255). If you look at the four steps in this show, you’ll see the first step turns off *l_light2* and turns on *l_light1*, the next one turns *l_light2* and turns off *l_light1*, etc. In other words, if this show runs in a loop you’ll get a

never ending 1-2-3-2-1-2-3-2-1-2-3-2... pattern. If you have RGB LEDs, then you can have some more fun and actually specify different colors for each light at each step. For example, if you just wanted to have a show that cycled three RGB LEDs through the colors of the rainbow, you could create a show like this:

```
#show_version=4
- duration: 1
  leds:
    l_led1: red
    l_led2: red
    l_led3: ff0000
- duration: 1
  leds:
    l_led1: ff6600
    l_led2: ff6600
    l_led3: ff6600
- duration: 1
  leds:
    l_led1: ffcc00
    l_led2: ffcc00
    l_led3: ffcc00
- duration: 1
  leds:
    l_led1: lime
    l_led2: 00ff00
    l_led3: 00ff00
- duration: 1
  leds:
    l_led1: blue
    l_led2: 0000ff
    l_led3: 0000ff
- duration: 1
  leds:
    l_led1: ff00aa
    l_led2: ff00aa
    l_led3: ff00aa
```

Obviously this is just the very beginning of what you can do. You can create shows that are hundreds of steps involving dozens of lights. (Notice that if you don't specify a change for a particular light for a step then that light just stays at whatever it was before. In other words, you only have to enter the new values for the lights that change each step—you don't have to enter all the lights from scratch every step.)

Again, notice that for the color of the LEDs, you can specify a color either in the form of a string name or a 6-digit hex color codes. If you go with names, you can use [any of these colors](#).

5. Configure your show to play

This new show file is just like your existing display show, except this one contains settings for lights or LEDs. So to get it to play, add it to the `show_player:` section of your attract mode config file, set to play on the `mode_attract_started` event just like the display show.

The only catch here is that the YAML file cannot have the same setting entered twice. (If you did this, the second one would overwrite the first one which would be really confusing. In fact if MPF sees that, MPF will exit and print a warning about the duplicate so you can fix it.)

MPF offers a way around this though, in that you can add a `.1` to the end of the event name, like this:

```
#config_version=4
show_player:
  mode_attract_started: attract_display_loop
  mode_attract_started.1: attract_light_show
```

Adding the `.1` doesn't really affect anything in terms of how this works, it just makes it so this is valid YAML and both entries get set. (And you can have more than one, `.2`, etc. In fact you can have any number, they don't have to be in order or anything.

You also might be wondering why we don't just make a single attract show and put the slides and LEDs or lights in the same show?

Certainly that's possible, but we like to keep things separate, as this will let you start and stop them on their own, and it will make it easier to tweak things (like the playback speed) of one thing without breaking other things.

Save your files, and run your game. You should see your light show and the display show start playing once the attract mode starts up.

If you're using the virtual interface without a real pinball machine, this is probably a good time to use the [MPF Monitor](#) to see that the light show is actually working. (Expand the "light" or "LED" section in the devices window to see your lights and watch the colors cycle.

6. Speed things up

While it's cool that the show is working, it's kind of lame because it runs so slow with 1 second between steps. So let's speed it up.

You could go into your show and adjust the `duration:` of each step, but that's kind of a pain since you have to change every single step, and it makes it annoying when you're playing with different values.

Instead, we like to tweak the playback speed of the show which is something we can do in the `show_player:` entry. (In fact, we almost always use the duration values in shows as a sort of "relative" duration of one step to another, and then set the actual speed at play time.

So if we want each step to be 1/4th of a second, we need to play the show at 4x the speed. Simple, just add a `speed: 4` to the `show_player` entry.

```
#config_version=4
show_player:
  mode_attract_started: attract_display_loop
  mode_attract_started.1: attract_light_show
  speed: 4

# don't try this, it won't work
```

If you try to run MPF with the config above, MPF will halt with the following error (scroll to the right to see it all):

```
ValueError: YAML error found in file /mpf-examples/tutorial_step_17/modes/attract/config/attract.yaml.
↪Line 6, Position 10
```

What gives?

The problem is that entries in YAML files can be *either* setting names and values or section names with subsections, but not both. So in the example above, it sees `mode_attract_started.1:` `attract_light_show` as a setting name and value, but then it also sees `speed: 4` indented under it. The YAML processor doesn't know what to do?

To fix this, we need to make a slight change to our YAML file, like this:

```
#config_version=4
show_player:
  mode_attract_started: attract_display_loop
  mode_attract_started.1:
    attract_light_show:
      speed: 4
```

What we've done is moved the show name (`attract_light_show`) under the event name (`mode_attract_started.1`), and then we added the speed setting under there.

If you wanted to, you could consolidate the duplicate `mode_attract_started` entries like so:

```
#config_version=4
show_player:
  mode_attract_started:
    attract_display_loop:
      speed: 1
    attract_light_show:
      speed: 4
```

Either option is fine, and you'll probably end up with both techniques scattered throughout your configs.

7. Configure more light shows to all run at once

The simple light show with two or three lights is a good first step, but it's hardly what could be considered a "real" attract mode light show. Unfortunately if you look at a real pinball machine, you might be overwhelmed by all the crazy light action. But if you really look closely, you'll realize that the super-complex looking light shows on real pinball machines are just lots of little shows all running at the same time.

For example, look at how we can break down the attract mode light show of *Demolition Man*:
https://www.youtube.com/watch?v=_h_rhHExmX4

So if we were creating the attract mode light show like this for MPF, we would actually create lots of little shows each with just a few lights in them. Then we'd end up with a list of show files, like this:

- `flipper_red_flashing.yaml`
- `purple_mode_sweep.yaml`
- `inlane_alternating.yaml`
- `random_flashing.yaml`
- `car_chase_sweep.yaml`
- `ramp_orbit_sweep.yaml`
- `right_orbit_sweep.yaml`
- `claw_sweep.yaml`

- mtl_sweep.yaml
- center_ramp_sweep.yaml
- standups_sweep.yaml

Again, we'd make every step of every show have a duration of 1. Then in our `show_player:` configuration, we'd configure the list of shows to play when the attract mode starts instead of just one. For example:

```
show_player:
  mode_attract_started:
    attract_display_loop:
      speed: 1
    flipper_red_flashing:
      speed: 2
    purple_mode_sweep:
      speed: 4
    inlane_alternating:
      speed: 3
    random_flashing:
      speed: 2
    car_chase_sweep:
      speed: 3
    ramp_orbit_sweep:
      speed: 5
  ...(truncated. you get the idea)
```

(If you were really duplicating the *Demolition Man* attract mode light show, you'd also want to implement a play list which plays sets of shows in timed sequences since the real machine does one thing with the lights for a few seconds, then another, etc.

Check out the complete config.yaml file so far

If you want to see a complete `config.yaml` file up to this point, it's in the `mpf-examples/tutorial_step_17` folder with the name `config.yaml`. You can run it by switching to that folder and running `mpf both`:

```
C:\mpf-examples\tutorial_step_17>mpf both
```

Tutorial step 18: Add your first shot

At this point you have a machine you can turn on, lights flash, the display works plays, you can hit start, you have a base mode with some simple scoring, and you can play complete games. Not bad! In this step we're going to introduce you to a key MPF concept called "shots", which is an important concept in MPF and something that you'll use a *lot* when you're putting together your game logic.

1. What's a shot?

First, take a look at the [introduction to shots](#) documentation to understand what a shot is.

2. Create your first shot

To define your a shot, you add a `shots:` entry to a config file, and then under there, you set the switch, timing, and other details that make up that shot.

You'd typically define your shots in your machine-wide config , since shots are based on that actual physical hardware. In this case the shot you define is available to be used in every mode (though you certainly don't have to use it in every mode.)

You can also define default behaviors for each shot in the machine-wide config (which you can then override in a specific mode if you want to do something different with that shot in that mode).

Let's start by creating our first shot in the machine-wide config file.

```
# config.yaml (machine-wide config file)

shots:
  my_first_shot:
    switch: s_right_inlane # pick a switch that's valid in your machine
```

Depending on your machine, you might not actually have a switch called “s_right_inlane”, so feel free to pick a different switch name. For now just keep it simple—a standup or a lane switch or something.

Also, to make following the tutorial easier, go ahead and call this shot “my_first_shot” even if you're using a different switch name. You can change the name of the shot to something more meaningful later.

Next, open the mode config file for your base mode, which is
<your_machine>/modes/base/config/base.yaml

Find the `scoring:` section that you added in Step 15, and change the first entry from `s_right_inlane_active:` to `my_first_shot_hit`, like this:

```
# base.yaml (config file for base mode)

scoring:
  my_first_shot_hit: # this was s_right_inlane_active
    score: 100
  s_flipper_lower_left_active:
    score: 1000
    potato: 1
  s_flipper_lower_right_active:
    potato: -2
```

Do you understand what this is doing?

Remember that the scoring section will add (or remove) value from a player variable when certain events happen. So the OLD entry from Step 15 would increase the score by 100 points when the event “s_right_inlane_active” happened, and the NEW entry changes that so the 100 points are added when the event “my_first_shot_hit” happens.

This illustrates something to know about shots: Whenever a shot is “hit”, then an event is posted with the name of the shot plus “_hit” added onto it.

So in this case, the shot “my_first_shot” will post then event “my_first_shot_hit” whenever that shot is made.

If you save your two changed config files and run MPF again, start a game with the S key, then hit the right inlane switch with the Q key, you should see the player's score increase by 100 points.

So it kind of looks like nothing really changed, except now we're using a real shot instead of scoring based on the switch entry.

At this point you might think that this is overly complicated. After all, everything worked fine before without having to mess with shots and all, so why bother?

Again, this is just a simple example to get you started. The real power of shots comes in as you define more complex shots, as you get into shot profiles (doing different things depending on the state of the shot), and enabling, disabling, blocking, and overriding shots based on different modes.

3. Change the shot profile

Every shot in MPF has a "shot profile" applied to it. (Since we didn't specify a profile in the shot we just created, it uses a default profile called, wait for it... "default".)

A shot profile is a list of steps (or states) for a shot. For example, the default profile (which is built-in to MPF) has two states:

1. unlit
2. lit

When a new game starts, the shots in MPF start at the first step of the profile. In other words, the shot called "my_first_shot" starts in the "unlit" state. Then when the shot is hit, the profile is advanced to the next step. (So when "my_first_shot" is hit, that shot advances from the "unlit" to the "lit" state.)

You can apply the same profile to multiple shots (and the state of each shot is tracked separately), so if you have "my_first_shot" and "my_second_shot", they both start "unlit", but if you hit "my_second_shot", then it advances to "lit" but "my_first_shot" stays in the "unlit" state.

Shot profiles have all sorts of settings (which we'll get to in a bit), including options for what happens when the shot is hit when it's in the final state—does it just stay there or does it go back to the first state? (The built in "default" shot profile will stay in the lit state even if it's repeatedly hit.)

Also, tracking which state a shot is at is done on a per-player basis, so if Player 1 advances a shot from "unlit" to "lit", then when Player 2 starts, that shot will be back in the "unlit" state.

One of the cool things about shot profiles is you can tie them to shows, and then when you define your shots, you can specify how those shows are played. In other words, you can associate a light or LED with your shot, and then that light will be off when the shot is "unlit" and then turn on when the shot is lit.

Let's do that now.

3a. Associate a light/led with your shot

To do this, go back to the machine-wide config (where you defined the shot) and change the shots: section.

If you have LEDs in your machine, change it to this:

```
# config.yaml (machine-wide config file)

shots:
```



```
my_first_shot:
  switch: s_right_inlane
  show_tokens:
    led: led_1 # pick an LED that's valid in your machine
```

If you have a lamp matrix, change it to this:

```
# config.yaml (machine-wide config file)

shots:
  my_first_shot:
    switch: s_right_inlane
    show_tokens:
      light: l_light_quick_freeze # pick a light that's valid in your machine
```

In either case, be sure to pick an LED or light name that is a valid light in your machine.

For now don't worry about what "show_tokens" is or what's happening. (We'll get to that.)

Save your config, then re-run MPF and start a game. The light or LED you picked should be off.

Now hit the switch for the shot. You should see the 100 point score increase, and you should also see the light or LED turn on. (If it's an RGB LED, it will turn on white. We can change that later.)

If you hit the switch again, you'll still get 100 points each time (since the "my_first_shot_hit" is happening each time), but the light won't turn off since the shot is staying in the "lit" state since the default shot profile isn't configured to go back to the first step when it gets to the last step.

3b. Create a custom shot profile

Next, let's create a custom shot profile that has more than the "lit" and "unlit" steps.

To do this, we'll again use the machine-wide config file and add a section called `shot_profiles:`. Create that section now, and define a shot profile called "my_first_profile" with the following settings

```
# config.yaml (machine-wide config file)

shot_profiles:
  my_first_profile:
    states:
      - name: unlit # step 1
        show: off
      - name: flashing # step 2
        show: flash
      - name: lit # step 3
        show: on
    loop: yes
```

Take a look at this shot profile to see what's happening.

First, notice that in the `my_first_profile:` section, there's a subsection called "states". This is a list of all the states (steps) that shots will use when this profile is applied. (Note the dashes to separate each step.)

The states/steps are listed in the order they'll cycle through as the shot is hit.

Each step has a name: setting which is the name of the step (or, more accurately, the name of the state that shot is in when a shot with that profile applied to it is at the step).

Also notice that each step has a show: setting. This is the name of the MPF show (just like display show we created in Step 16 or the light show we created in Step 18). These shows need to be valid shows within MPF. In this case we're using shows named "off", "flash", and "on", as those are valid names for three shows that are built-in to MPF.

What's basically happening here is that when a shot with this profile applied is at the first step of the profile, the state name will be called "unlit" and the show called "off" will be played. Then when the shot is hit, it will advance to the next step, which is called "flashing" in this case. The show called "unlit" will be stopped, and then the show called "flash" will be played. If the shot is hit again, it will advance to the "lit" state, the "flash" show will stop, and the show called "on" will be started.

This shot profile also includes a loop: yes (this could be loop: true) setting that means when a shot is hit that's in the last step of the profile, it will loop back to the first step. (So hitting the shot when it's lit means the shot will loop back to "unlit".)

3c. Apply the new profile to the shot

Simply creating a shot profile doesn't mean that any shots use it. It just means that profile is available to be used, much like how creating a show is separate from playing the show.

So next we need to tell our shot that it should use the new profile we just created by adding a profile: setting.

```
shots:
  my_first_shot:
    switch: s_right_inlane
    show_tokens:
      led: led_1 # or use light: here, depending on your machine
    profile: my_first_profile
```

Save your config and re-run MPF. Once you start a game, the light or LED from your shot should be off. Hit the switch for the shot, and the light or LED should starting flashing. (It will be slow—1 second on, 1 second off.) Hit it again, and it should go on solid. Hit it again and the shot will go back to the "unlit" state. Hit it again and the light or LED should flash. Etc.

Note that you must actually start a game for this to work. Shots are only active when games are in progress, and the state is tracked per-player which means that players must exist, etc.

If you play a multi-player game, you should see that the state of that shot is maintained and restored separately for each player.

3d. Apply custom scoring based on state

Remember that the scoring: section of the base mode config scores 100 points each time that shot is hit. So as you're hitting the switch over and over to cycle through the states, each time you do that the player gets 100 points.

That scoring entry is based on the my_first_shot_hit, which is generated every time that shot is hit since shots make events in the form <shot_name>_hit.

However, each time a shot is hit, there's are two ADDITIONAL events posted which are <shot_name>_<profile>_hit and <shot_name>_<profile>_<state>_hit.

For example, when you start a new game with the shot and shot profile we've been working with, when you hit the switch for that shot, three shot-related events will be generated:

- `my_first_shot_hit` (shot + "hit")
- `my_first_shot_my_first_profile_hit` (shot + profile + "hit")
- `my_first_shot_my_first_profile_unlit_hit` (shot + profile + state + "hit")

When you hit that same shot a second time, the following three events will be generated: The first two are the same since they're based on shot name and profile name, but the last one is different because the shot's state is different.

- `my_first_shot_hit` (shot + "hit")
- `my_first_shot_my_first_profile_hit` (shot + profile + "hit")
- `my_first_shot_my_first_profile_flashing_hit` (shot + profile + state + "hit")

Hitting that shot again will generate the following three events:

- `my_first_shot_hit` (shot + "hit")
- `my_first_shot_my_first_profile_hit` (shot + profile + "hit")
- `my_first_shot_my_first_profile_lit_hit` (shot + profile + state + "hit")

And so on...

Now let's look at how we can give the player a different number of points when they hit that shot depending on what state the shot's in.

Here's the existing scoring section from the base mode config:

```
# base.yaml (config file for base mode)

scoring:
  my_first_shot_hit:
    score: 100
  s_flipper_lower_left_active:
    score: 1000
    potato: 1
  s_flipper_lower_right_active:
    potato: -2
```

Again, the player gets 100 points each time that shot is made regardless of what state it's in since the scoring event is the generic shot hit event which does not include details of what state the shot is in.

Now let's change the scoring section to this:

```
# base.yaml (config file for base mode)

scoring:
  my_first_shot_my_first_profile_unlit_hit:
    score: 100
  my_first_shot_my_first_profile_flashing_hit:
    score: 1000
  s_flipper_lower_left_active:
    score: 1000
    potato: 1
```



```
s_flipper_lower_right_active:
  potato: -2
```

We changed the name of the event for the first scoring entry from “my_first_shot_hit” to “my_first_shot_my_first_profile_unlit_hit”. This means those 100 points will only be added if that shot is hit while it has the “my_first_profile” applied AND while that profile is in the state “unlit”.

The next entry, for 1000 points, will only be called when that shot is hit with “my_first_profile” applied while it’s in the state “flashing”.

Save your config and run your game. If you hit the switch for the shot, you should get 100 points and the light should start flashing. Hit it again, and you should get 1000 points and the light should turn on steady. Hit it a third time, and you should get no points, but the light will also turn off since the profile is set to loop and it will go back to the first (unlit) state.

In other words, hitting the Q key (or the actual switch if you have a real machine) should result in the following sequence of total score (one for each hit): 100, 1100, 1100, 1200, 2200, 2200, 2300, 3300, 3300...

4. Add a second mode and score the shot from there

One of the most powerful features of shot profiles is that shots can have multiple profiles defined at the same time, (with each active mode having the ability to apply its own profile).

To illustrate this, we’re going to create a new mode, called “mode2”. So go ahead and create a mode2 folder in your modes folder, then add the config folder into that folder, and then create the mode2.yaml mode configuration file for that mode.

Open up the mode2.yaml file and add the following lines. (We’ll explain them step-by-step next.)

```
#config_version=4
# mode2 config file

mode:
  start_events: mode2_start
  stop_events: mode2_stop
  priority: 200

widgets:
  mode2_start_banner:
    type: text
    text: MODE 2 STARTED
    font_size: 50
    color: lime
    y: 80%
    expire: 1s

widget_player:
  mode_mode2_started: mode2_start_banner

scoring:
  my_first_shot_hit:
    score: 1
```


Remember that you also have to go back into your machine-wide config file to add the new `- mode2` entry to your `modes:` section. While we're in there, let's also add `keyboard:` entries for some events we can use to stop and start the mode.

Here are changes you'll make to the machine-wide config file:

```
# from the machine-wide config.yaml file

modes:
  - base
  - mode2

...

keyboard: # existing keyboard entries not shown.
  n:
    event: mode2_start
  m:
    event: mode2_stop
```

Now save your files and run your machine. Then press the following keys:

- S - starts the game
- Q - hits your shot, score jumps to 100
- Q - hits your shot, score jumps to 1100
- N - starts mode2. You should see a 1-second green message showing this
- Q - hits your shot, score jumps to 1101
- Q - hits your shot, score jumps to 1202

You can press M to stop mode2 (though there is no on-screen message) and then continue to hit Q and notice the score jumps through the [+100, +1000, 0] cycle over and over.

You can press N again to start mode2 and notice that every time you press Q, you the score increases +1 (in addition to the [+100, +1000, 0] from the base mode).

Press M to stop mode2 again and notice that the +1 scoring stops.

So what's happening here?

First, notice that in the `mode2.yaml` file, we configured the following scoring entry:

```
scoring:
  my_first_shot_hit:
    score: 1
```

Notice that that scoring entry is just based on "my_first_shot" being hit. It does not contain any of the profile or state information in it, which means that it will always score the +1 regardless of the state of that shot.

Of course even while mode2 is running, the base mode is also running. That means that when both modes are running, mode2 is always scoring +1 per hit, and the base mode is cycling through the [+100, +1000, 0] scoring depending on what state the shot is in.

When you stop mode2 (with the M key), that removes the scoring from mode2, but since the base mode is still running, you still get the scoring from there.

5. Configure a new shot profile in mode2

In the previous step, we added a new mode and accessed the shot from within that mode, but that new mode still used the same shot profile as the base mode.

However, it's also possible to create a brand-new shot profile in a mode that will be applied to the shot when that mode is active.

This is useful if you want to “override” a shot profile from a lower mode based on a higher priority mode. For example, maybe you have a stand-up target in your base mode that you're using for some basic scoring. But then in a jackpot mode, you want that target to flash a light instead of just the regular on/off behavior from the base mode. You would do this by applying a different shot profile in the jackpot mode.

To illustrate this, open up your `mode2.yaml` file and:

1. Updated the `scoring:` section from the example below
2. Add the `shots:` section from below
3. Add the `shot_profiles:` section from below

```
# snippet from mode2.yaml

...

scoring:
  my_first_shot_mode2_flashing_hit:
    score: 10000
  my_first_shot_mode2_lit_hit:
    score: 100

shots:
  my_first_shot:
    profile: mode2

shot_profiles:
  mode2:
    states:
      - name: flashing
        show: flash
        speed: 5
      - name: lit
        show: on
    loop: no
    block: yes
```

Save your files and run your game again, pressing the following keys:

- S - starts the game
- Q - hits your shot, score jumps to 100,
- Q - hits your shot, score jumps to 1100
- N - starts mode2. You should see a 1-second green message showing this
- Q - hits your shot, score jumps to 11,100
- Q - hits your shot, score jumps to 11,200

- Q - hits your shot, score jumps to 11,300
- M - stops mode2
- Q - hits your shot, no score change
- Q - hits your shot, score jumps to 11,400
- Q - hits your shot, score jumps to 12,400

Let's deconstruct the changes to the mode2.yaml config file too see what's going on.

First, notice that we added a shots: section and then added "my_first_shot" to it, like this:

```
shots:
  my_first_shot:
    profile: mode2
```

However, unlike the "my_first_shot" entry in the machine-wide config, in the mode config we did NOT redefine the switch: or show_tokens: entries. Instead, we just added the profile: setting and told it to use a profile called mode2.

So what this means is that we're not creating a new shot or changing the configuration of the shot, rather, we're just saying that when mode2 is active, we want to apply a different shot profile to the shot. (Remember that settings from mode configuration files are only active when that mode is active.)

Next, take a look at the shot_profiles: section:

```
shot_profiles:
  mode2:
    states:
      - name: flashing
        show: flash
        speed: 5
      - name: lit
        show: on
    loop: no
    block: yes
```

In this case, we defined a profile called mode2 which has two states: "flashing" and "lit". (These state names could be whatever you want, "incomplete" and "complete" or whatever.) Note also that we added speed: 5 to the flashing step. That setting will be applied to the "flash" show when it's played, and you can use any of the [show_player:](#) settings there. In this case that will play the show at 5x speed, so we'll see a fasting flashing.

Also note that we added block: yes to this profile. That means that when this profile is active, any shot profiles from lower priority modes will be disabled. Since mode2 runs at priority 200, the profile "my_first_profile" which we assigned in the machine-wide config will be blocked. (Machine-wide config items run at priority 0.)

And, since the scoring events in the base mode are based on the shot being hit with the "my_first_profile" applied, this is why when mode2 is running, we don't get the scoring events from the base mode. Those events are not posted because my_first_profile is not active because the higher priority profile attached to the shot in mode2 is blocking it.

If you were to remove the block: yes from the mode2 profile in the mode2 config, then when you hit the shot while mode2 was active then you would get the scoring from both the base mode and mode2 mode applied.

(not done writing yet...)

Next steps to write

- Show tokens
- Shot groups
- advancing shots
- shot reset events

Check out the complete config.yaml file so far

If you want to see a complete config.yaml file up to this point, it's in the mpf-examples/tutorial_step_18 folder with the name config.yaml. You can run it by switching to that folder and running mpf both:

```
C:\mpf-examples\tutorial_step_18>mpf both
```

Even if you have real hardware, it's probably worth running the MPF Monitor which will show you the events as they're posted that correspond to the shot being hit and it changing profiles.

MPF compatible control systems / hardware

MPF controls a pinball machine by interfacing to a modern pinball control system. (See the [MPF Overview](#) for details.) MPF itself is hardware-independent, meaning that MPF (and the configs and code you build) runs on a [normal/embedded PC](#) and can work with lots of different kinds of control systems and hardware devices.

Not only does this give you a choice of what type of pinball control hardware you want to use, it also means that you have the flexibility to change your hardware at any time without having to change any game code. You could even release a game code update that works on multiple platforms—all with the same code!

[Here's a demo video](#) of us switching out a P-ROC controller for a FAST controller in 3 minutes and running the same game code on both.

It's possible to mix-and-match multiple types of hardware in a single MPF machine config. For example, you could combine the SmartMatrix RGB DMD with a FAST Core controller, or a FadeCandy LED controller with a P-ROC, etc. (You can even mix-and-match platforms within the same type of device, meaning you could have some LEDs attached to a FAST Pinball controller and others attached to a FadeCandy. See the [Mixing-and-Matching hardware platforms](#) guide for details.)

MPF currently supports the following hardware control systems. We are always adding more, so if there's a hardware device that you'd like to use that we don't support, let us know. (Or better yet, write your own interface to it and submit a pull request to the MPF codebase!)

List of supported control systems & hardware

Here's a list of all the different types of control systems and hardware that MPF currently supports. If there's a type of hardware you'd like us to support that you don't see on this list, please [post a message to the MPF Users Google Group](#) and we'll go from there.

Primary control systems

You'll need to pick one of these three as the main interface between MPF and your pinball machine.

- ***FAST Pinball***
 - Core Controller, Nano Controller, WPC Controller
 - 0804, 1616, 3208 I/O Boards
 - Servo controller daughter board
 - Power Filter Driver Board coin-door interconnect
 - Plasma & LED mono DMDs (Core & WPC controllers)
 - FAST RGB LED-based DMD
- ***Multimorphic***
 - P-ROC with PDB driver boards (PD-16, PD-8x8, PD-LED)
 - P-ROC in all supported existing machines (Williams, Stern, etc.)
 - P3-ROC with PDB driver boards (PD-16, SW-16, PD-LED)
 - Plasma & LED mono DMDs (P-ROC)
 - Accelerometer-based tilt (P3-ROC)
- ***Open Pinball Project (OPP) controllers***
 - Gen 2 OPP hardware, with many combinations of wing boards for drivers, switches, & incandescent lights
- ***Stern SPIKE / SPIKE 2 machines***
 - *New in MPF 0.33*
 - A computer running MPF can directly connect to a SPIKE machine with a simple “USB to serial” converter which you plug into the SPIKE main board.
- ***LISY***
 - *New in MPF 0.50*
 - Gottlieb System 1
 - Gottlieb System 80
- ***Virtual (software-only) controllers***
 - MPF includes virtual hardware interfaces you can use to run MPF when it's not connected to physical hardware. (This is good for working on your game when you're not around your machine, or if you don't have real hardware yet.)
 - The *MPF Monitor* is a graphical tool you can also use to visually interact with MPF which is especially useful if you're not using MPF with physical hardware.

Additional supported hardware

The following hardware devices can be combined with primary control systems to provide additional functionality.

- ***Snux System 11 driver board***
 - Supported in combination with the P-ROC or FAST WPC controller
 - Supported for System 11, 11A, 11B, 11C
 - Should work in Data East machines too, though it's never been tried
- ***I2C Servo Controllers***
 - Servos connected to I2C-based servo controllers
- ***Fadecandy RGB LED controllers***
 - 512 RGB LEDs per Fadecandy
 - Can connect multiple Fadecandys to support more LEDs
- ***Pololu Maestro servo controllers***
 - Supports up to 24 servos per board
- ***SmartMatrix RGB LED display controller***
 - Supports a “real” color DMD made up of RGB LED matrix
- ***RGB.DMD RGB LED display controller***
 - Supports a “real” color DMD made up of RGB LED matrix

Configuration Guides

We have configuration guides which show you how to setup and use different types of pinball mechanisms with the various control systems and hardware that MPF supports:

How to configure MPF for FAST Pinball hardware

Here's a list of all the How To guides which explain how to use MPF with FAST Pinball hardware. These guides include the numbering format (how you map specific entries in your config files to board and connector locations) as well as overall settings that affect how your FAST hardware performs. (Watch dogs, update speeds, etc.)

How to use install drivers & configure COM ports (FAST Pinball)

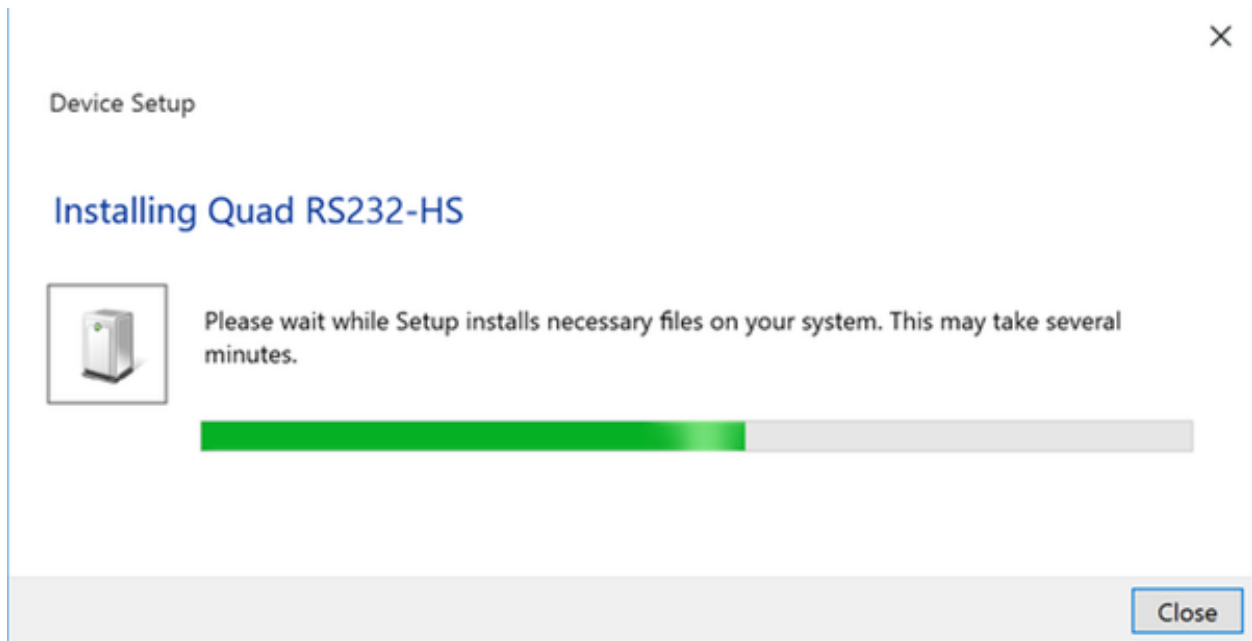
Related Config File Sections
<i>hardware:</i>
<i>fast:</i>

This guide explains how to configure MPF to work with a FAST Pinball controller. It applies to all three of their models—the Core, Nano, and WPC controllers.

1. Install the FAST USB driver

FAST Pinball controllers use a USB chip from FTDI, so you need to download and install the FTDI driver. It's pretty simple. Go to this [this page](#) and scroll down to the VCP Drivers section and download the driver for your OS. If you're using Windows, we think it's easier to use the "setup executable" they link to in the comments.

Once this is done, when you plug in and power on your FAST controller, you should see some kind of notification that new hardware has been detected. What exactly you see will depend on which FAST controller you're using and what OS you have. For example, here's what happens when you plug a FAST WPC controller into Windows 10 for the first time (after you've installed the FTDI driver):



(This is just a progress bar which shows Windows configuring the drivers. You don't have to click anything to get it started, and it should only take 5-10 seconds. It will only happen the first time you plug in the hardware.)

2. Configure your hardware platform for FAST

To use MPF with a FAST, you need to configure your platform as fast in your machine-wide config file, like this:

```
hardware:  
  platform: fast  
  driverboards: fast
```

You also need to configure the *driverboards:* entry for what kind of driver boards you're controlling.

Use *driverboards: fast* if you're using FAST I/O boards (like the 3208, 0804, etc.), or use *driverboards: wpc* if you're using an existing WPC or Snux System 11 driver board.

3. Find the FAST COM ports

Even though the FAST controllers are USB devices, they use “virtual” COM ports to communicate with the host computer running MPF. On your computer, if you look at your list of ports and then connect and power on your FAST controller, you will see 4 new ports appear. The exact names and numbers of these ports will vary depending on your computer, what other devices you have, and which port you plug the FAST controller into, but the order of which ports do what is the same everywhere:

- First (lowest numbered) port: **DMD Processor**
- Second: **NET processor** (the main processor)
- Third: **RGB LED processor**
- Fourth: **Unused** (available for your own custom use!)

Note that the FAST Nano controller does not have a DMD processor, so on that device, both the first and fourth ports are unused.

You need to tell MPF which ports are used for the FAST Controller, and the first step to doing that is to figure out what the port names are on your system:

Finding the COM ports on Windows

On Windows, it’s easiest to use the Device Manager. Right-click on the Start button (or whatever it’s called now) and choose “Device Manager” from the popup menu.

Then expand the “Ports (COM & LPT)” menu section to see which ports the FAST Controller is using. The easiest way to do this is to open the Device Manager to that section, then plug your FAST Controller in (or power it on) and just see which for port names appear.

The port names will start with “COM” and then be a number, and there will be four consecutive numbers to represent the four FAST ports.

Finding the COM ports on Mac or Linux

On Mac or Linux, it’s easiest to find the port numbers via the terminal window (or console window). To do that, open a new window and run the following command:

```
ls /dev/tty.*
```

This will list all the devices whose names begin with “tty”.

The four FAST ports will have the name that starts with “tty.usbserial-”, then a number, then a letter A-D. (The number will be different on every system.) The port ending with the “A” is the first port, the “B” is the second, etc.

For example, the four FAST ports might be something like on MAC:

```
/dev/tty.usbserial-141A  
/dev/tty.usbserial-141B  
/dev/tty.usbserial-141C  
/dev/tty.usbserial-141D
```

On linux it would look like this:


```
/dev/ttyUSB0
/dev/ttyUSB1
/dev/ttyUSB2
/dev/ttyUSB3
```

If you have multiple FAST devices they will enumerate more or less randomly dependent on the order they are plugged in. Unfortunately, the USB devices do not contain any serial number. However, we can pin them based on the USB port they are plugged into. On linux this can be achieved using a UDEV rules such as this:

```
SUBSYSTEM=="tty", ATTRS{idVendor}=="0403", ATTRS{idProduct}=="6011", ENV{ID_PATH_TAG}=="pci-0000_00_14_0-usb-0_12_1_0", SYMLINK+="ttyDMD1"
```

The device will then be available as /dev/ttyDMD1. You can run the following command while plugging in the device to get the relevant ID_PATH_TAG (and also idVendor and idProduct in case they changed with other revisions):

```
udevadm monitor --property
```

4. Add the ports to your config file

Next you need to add the ports to your machine config file. To do this, create a new section called `fast:`, and then add a `ports:` setting under it.

Then if you have a FAST Core or WPC controller, enter the names of the first three ports. If you have a FAST Nano controller, enter the names of the middle two ports (the second and third, since the first isn't used on a Nano).

So an example for Windows might look like this:

```
fast:
  ports: com3, com4, com5
```

And an example for Mac or Linux might look like this:

```
fast:
  ports: /dev/tty.usbserial-141B, /dev/tty.usbserial-141C
```

Note that if you have a FAST Core controller but you're not actually using the hardware DMD, then you don't have to enter the first port in your config. (Same is true if you're not using the LED controller.) MPF queries each port in this list to find out what's actually on the other end and then sets itself up appropriately.

Note that if you're using a version of Windows before Windows 10 and you have COM port numbers greater than 9, you will have to enter the port names like this: `\\.\COM10`, `\\.\COM11`, `\\.\COM12`, etc. (It's a Windows thing. Google it for details.)

There are more settings in the `fast:` section of the machine config that we have not covered here, but the ports are the bare minimum you need to get up and running.

5. Configure your watch dog timeout

FAST Pinball controllers have the ability to use a *watch dog* timer. This is enabled by default with a timeout of 1 second. If you would like to disable this, or you'd like to change the timeout, you can do so in the `fast:` section of your machine-wide config.

```
fast:
  ports: com3, com4, com5 # or whatever your ports are
  watchdog: 1000
```

The `watchdog:` setting is the timeout in milliseconds. Use 0 to disable it.

Note that at this time, FAST Pinball controllers only use the watch dog for the NET processor (which controls stuff on the IO boards, like coils). The watch dog is not used for the DMD or LEDs.

How to configure switches (FAST Pinball)

Related Config File Sections
<i>fast:</i>
<i>switches:</i>

To configure switches with FAST Pinball hardware, you can follow the guides and instructions in the *Switches* docs.

However there are a few things to know and some additional options you get with FAST hardware that is discussed here.

number:

When you're using FAST IO boards, switches plug into individual IO boards. Then the IO boards are connected together in a loop.

The `number:` setting for each switch is its board's position number in the chain, then the dash, then the switch input number. Note that the position number starts with zero, so the first IO board in the chain is 0, the second is 1, etc.

```
switches:
  my_switch:
    number: 0-0 # first board, switch 0
  some_other_switch:
    number: 2-24 # third board, switch 24
```

Notes:

- The first board in the chain is board 0.
- The boards are counted in the direction of the "out" connector on the controller board.
- Different models of IO boards have different numbers of switches, and MPF will make sure that the numbers work for each type of board. (e.g. a switch number 10 isn't valid on an 0804 board since that board only has 8 switches numbered 0-7).

Also note that prior versions of MPF just numbered all the switches in one continuous sequence from the first board through the last, but that was confusing. You can still do that if you want (in either hex or integer format), but we feel the board-input format is much easier to understand.

Debounce options

FAST controllers have advanced capabilities when it comes to debouncing switches. (More on what that is [here](#)).

Since FAST switches are directly connected (e.g. there is no switch matrix), and since every FAST IO board has its own processor and firmware, the states of switches are checked often (every 1ms). You can specify the exact debounce time that a switch must consistently be in a new state in both the open and close directions.

Specifying default debounce settings

By default, MPF provides two debounce profiles for switches (“normal” and “quick”). When using FAST pinball controllers, the “normal” debounce profile is 10ms for both the debounce open and debounce closed times, and the “quick” debounce profile is 2ms for both debounce open and closed times.

You can change any of these in the `fast:` section of your machine-wide config, like this:

```
fast:
  default_quick_debounce_open: 2ms
  default_quick_debounce_close: 2ms
  default_normal_debounce_open: 10ms
  default_normal_debounce_close: 10ms
```

(Note that other settings from the `fast:` section of your config have not been included here for clarity.)

Per-switch debounce settings

When using FAST Pinball controllers, you can also specify the debounce open and debounce closed settings on a per-switch basis. To do that, just add a `debounce_open:` and/or `debounce_close:` setting to an individual switch, like this:

```
switches:
  my_switch:
    number: 1-0
    debounce_open: 5ms
    debounce_close: 20ms
  some_other_switch:
    number: 3-24
```

Valid values are 1 to 255 ms.

How to configure coils/drivers/magnets (FAST Pinball)

Related Config File Sections
<i>fast:</i>
<i>coils:</i>

To configure coils, drivers, motors, and/or magnets (basically anything connected to an IO board's driver outputs) with FAST Pinball hardware, you can follow the guides and instructions in the [*Coils \(Solenoids\)*](#) docs.

However there are a few things to know and some additional options you get with FAST hardware that are discussed here.

number:

When you're using FAST IO boards, drivers plug into individual IO boards. Then the IO boards are connected together in a loop.

The `number:` setting for each driver is its board's position number in the chain, then the dash, then the driver output number. Note that the position number starts with zero, so the first IO board in the chain is 0, the second is 1, etc.

```
coils:
  my_coil:
    number: 0-0 # first board, driver 0
  some_other_coil:
    number: 2-14 # third board, driver 14
```

Notes:

- The first board in the chain is board 0.
- The boards are counted in the direction of the “out” connector on the controller board.
- Different models of IO boards have different numbers of drivers, and MPF will make sure that the numbers work for each type of board. (e.g. a driver number 10 isn't valid on an 0804 board since that board only has 4 drivers numbered 0-3).

Also note that prior versions of MPF just numbered all the drivers in one continuous sequence from the first board through the last, but that was confusing. You can still do that if you want (in either hex or integer format), but we feel the board-input format is much easier to understand.

Pulse Power

In the [*Coils \(Solenoids\)*](#) section of the documentation, we talked about [*how adjusting a coil's pulse time can affect its strength*](#). Adjusting the coil's pulse times still assumes that 100% power will be applied to that coil during that pulse time.

However, FAST Pinball controllers allow you to specify the power that's applied to the coil during the initial pulse time. This is similar to the [*Adjust coil hold power*](#), except it applies to the initial pulse time instead of the extended hold time.

You can configure the pulse power by adding a `pulse_power:` setting to a coil definition and then specifying the power value from 0-8. (Like hold power, 8 is 100%, 4 is 50%, etc.)

For example, consider the following configuration:

```
coils:
  some_coil:
    number: 1-3
    pulse_ms: 30
    pulse_power: 4
```

When MPF sends this coil a pulse command, the coil will be fired for 30ms at 50% power. You can even combine pulse_power and hold_power, like this:

```
coils:
  some_coil:
    number: 1-3
    pulse_ms: 30
    pulse_power: 4
    hold_power: 2
```

In this case, if MPF enables this coil, the coil will be fired at 50% power for 30ms, then drop down to 25% power for the remainder of the time that it's on.

Fine-tuning Power Values

FAST Pinball hardware also allows you to fine-tune the exact timings of the pulse_power and hold_power values. By default, the pulse_power and hold_power values from 0 to 8 map to an 8-bit PWM mask, like this:

- 0: 00000000
- 1: 00000001
- 2: 10001000
- 3: 10010010
- 4: 10101010
- 5: 10111010
- 6: 11101110
- 7: 11111110
- 8: 11111111

Each digit in the mask is 1ms, with a 1 being “on” and a 0 being “off”. Then that pattern is repeated as long as necessary. In other words, the power value of 4 is 10101010 which is on for 1ms, off for 1ms, on for 1ms, etc.

That should work fine for most cases, there could be scenarios where you might want more fine-grained control. To enable this, you can use pulse_pwm_mask: and hold_pwm_mask: settings where you actually enter an 8-digit strings of ones and zeros for the mask. For example:

```
coils:
  some_coil:
    number: 1-3
    pulse_ms: 30
    hold_pwm_mask: 11001100
```


In the example above, the coil is still getting 50% power, but it's turning on and off every 2ms instead of every 1ms. Again, usually this isn't something you have to worry about, but it's nice to be able to fine tune things, especially when you have non-standard coils or things like magnets.

For really fine-grained scenarios, FAST also has the ability to use 32-bit pwm masks, like this:

```
coils:
  some_coil:
    number: 1-3
    pulse_ms: 30
    hold_power32: 10011100011001110001100111000110
```

The 32-bit mask is just like the 8-bit mask, where each digit represents 1ms. It's just that the 32-bit version lets you specify a 32ms-long repeating pattern, versus the 8-bit one which is an 8ms-long repeating pattern.

There are both `hold_power32:` and `pulse_power32` settings for coils and drivers using FAST hardware.

Note: In case it's not obvious, for each coil you can only choose one setting from `pulse_power:`, `pulse_power32:`, and `pulse_pwm_mask:`, and one setting from the "hold" variants of the three of them.

Setting Recycle Times

FAST Pinball controllers allow you to precisely control the *recycle time* for coils or drivers.

A coil's recycle: setting is a boolean (True/False), which is set to False by default. When using FAST Pinball hardware, if you set `recycle: true`, then the recycle time is automatically set to twice the coil's `pulse_ms:` setting. (e.g. a coil with a `pulse_ms: 30` and `recycle: true` will have a 60ms recycle time).

However, with FAST Pinball hardware, you can manually set a coil's recycle time by adding a `recycle_ms:` setting, like this:

```
coils:
  slingshot_r:
    number: 1-4
    pulse_ms: 30
    recycle_ms: 100
```

If you manually specify a `recycle_ms` value, then that's the value that's used and the coil's `recycle: (true/false)` setting is ignored.

How to configure Flippers, Slingshots, Pop Bumpers, and other "quick response" devices (FAST Pinball)

MPF uses some special tricks to ensure that "quick response" devices like flippers, slingshots, and pop bumpers are able to respond to switch changes as fast as possible. (Read more about that [here](#).)

When using FAST Pinball hardware, there are a few things you should know about these hardware rules.

First, remember that FAST IO boards contain both switch inputs and driver outputs.

For best performance, either:

1. Make sure switches & drivers for hardware rules are on the same IO board, or

2. Make sure switches are the first 8 switches on the first IO board

In other words, if you have a pop bumper or slingshot, make sure that the activation switch for that device and the coil for that device are plugged into the same IO board. That shouldn't be too hard, since you'll have multiple IO boards underneath your playfield.

For flippers, however, that's probably not possible, so FAST Pinball controllers use the concept of "priority" switches which are the first 8 switches plugged into the first board in the chain. (These will be the switches numbered 0-0 through 0-7.)

These priority switches are sent across the FAST loop network immediately which means they can be used with hardware rules to trigger drivers (coils) on any IO board in the network.

If you only have two flippers in your machine, this is probably nothing you'll ever need to worry about since it will be easy to connect the flipper switches and coils to the same IO board (and of course the same will be true for all the other quick response devices in your machine).

But if you have more than two flippers, there's a good chance that the additional flippers will be somewhere far away from the flipper buttons and the main flippers. In that case, no problem, but make sure the IO board that has your flipper buttons connected to it is the first one in the chain, and make sure your flipper buttons are connected to one of the 0-7 positions on that IO board, and then everything will be fine.

How to configure LEDs (FAST Pinball)

Related Config File Sections
<i>leds:</i>
<i>fast:</i>

Each FAST Pinball Controller has a built-in 4-channel RGB LED controller which can drive up to 64 RGB LEDs per channel. This controller uses serially-controlled LEDs (where each LED element has a little serial protocol decoder chip in it), allowing you to drive dozens of LEDs from a single data wire. These LEDs are generally known as "WS2812" (or similar). You can buy them from many different companies, and they're what's sold as the "NeoPixel" brand of products from Adafruit. (They have all different shapes and sizes.)

Most of the settings in the [LEDs](#) documentation apply to LEDs connected to FAST Pinball controllers, however there are a few FAST-specific things to know.

number:

There are two ways you can configure RGB LEDs for your FAST controller: by channel & output number, or directly with the FAST hardware number. It's more straightforward to configure them by channel and output, like this:

```
leds:
  l_led0:
    number: 0-0
  l_right_ramp:
    number: 2-28
```

In the example above, RGB LED `l_led0` is LED #0 on channel 0, and `l_right_ramp` is LED #28 on channel 2. Note both the channel and LED numbers start with 0, so your channel options for a FAST

controller are 0-3, and your LED number options are 0-63. Also note that when you enter your FAST LED numbers with a dash like this, the values are integers, even if the rest of your FAST settings are in hex.

If you know the actual hex numbers of your LEDs, you can enter the numbers like that, ranging from 00 to FF. If you don't know what this means, then just ignore it and use the channel and LED number format with the dash. :)

RGB LED buffering

Most computers have the ability to send LED updates to the FAST Pinball controller faster than the controller can process them. If this happens, then the LED command messages can get backlogged and it will appear that you have a “delay” in your LEDs and/or you might get weird colors due to corrupt messages.

To help combat this, there are two settings you can adjust:

```
mpf:
  default_led_hw_update_hz: 50

fast:
  rgb_buffer: 3
```

If you notice that your LEDs seem to be getting behind, you can adjust the `default_led_hw_update_hz` setting to be lower. (Frankly the 50hz by default is too high and we should lower it to 30.) You can probably drive 128 or so LEDs at 50Hz, but if you have more than that then you might need to start playing with this number.

Hardware LED fading

You can globally set the fade rate for LEDs connected to a FAST Pinball controller via the `fast:hardware_led_fade_time` setting. (This is 0ms by default, meaning it's disabled.)

See the [fast](#) section of the config file reference for details.

How to configure Matrix Lights (FAST Pinball)

Related Config File Sections
matrix_lights :

Matrix lights are currently only supported on FAST Pinball via their WPC Controller. Like the other WPC-related settings in MPF, you can enter the numbers right out of your operators manual, so there's nothing FAST-specific you have to do.

How to configure mono/traditional DMD (FAST Pinball)

Related Config File Sections
physical_dmds :

The FAST WPC and Core controllers can drive traditional single-color pinball DMDs via the 14-pin DMD connector cable that's been in most pinball machines for the past 25 years, like this:



It makes no difference as to whether you're using an LED or an original plasma gas DMD. (Also it doesn't matter what color it is.)

1. Verify your port settings

In order to use a DMD with a FAST Pinball controller, you need to have the port that's connected to the DMD processor on the FAST board listed in the `ports:` section in the `fast:` section of your machine-wide config.

See the [How to use install drivers & configure COM ports \(FAST Pinball\)](#) guide for details.

2. Add a physical DMD device entry

Once you have your hardware and port set, you need to create the actual device entry for the DMD.

You do this in the `physical_dmds:` section of the machine config. This section is like the other common sections (switches, coils, etc.) where you enter the name(s) of your device(s), and then under each one, you enter its settings.

(And yes, in case you're wondering, it's possible to have more than one physical DMD.)

To do this, create a section in your machine-wide config called `physical_dmds:`, and then pick a name for the DMD, like this:

```
physical_dmds:
  my_dmd:
    shades: 16
```

You need to have at least one setting for this to be a valid YAML file, so we usually just pick the shades and add that with a value of 16 (which means the DMD runs will convert the display content to 16 mono shades when it displays it).

The “shades” option is how many brightness shades you want. 1990s WPC machines supported 4 shades, and modern Stern DMD machines support 16. The FAST Pinball controllers support 16 shades

(even on older 1990s plasma DMDs). Most modern games will probably be 16 shades, but you can do 4 (or even 2) if you want an old school look.

There are lots more options for the `physical_dmd:` section than just the “shades” option listed here. Check the [physical_dmds:](#) for a list of all the options.

Note that one option you do NOT have for physical DMDs is the color. That’s because the color of the DMD is determined by the DMD itself. You don’t actually send it color values, rather, you just send it brightness levels, and the DMD shows those brightness levels with whatever color the DMD is.

3. Set a source display

Now that you have everything configured, the last step is to make sure the DMD knows what content to show. In MPF, you do this by mapping a physical DMD to an [MPF display](#).

By default, the DMD will look for a display (in your [displays:](#) section called “dmd”. However you can override this and configure the DMD to use whatever logical display you want by setting a `source_display:` setting. (Just make sure that the width and height of your source display match the physical pixel dimensions of the DMD or else it will be weird.)

A final config you can test

At this point you’re all set, and whatever slides and widgets are shown on the DMD’s source display in MPF-MC should be shown on the physical DMD.

That said, all these options can be kind of confusing, so we created a quick example config you can use to make sure you have yours set right. (You can actually just save this config to `config.yaml` in a blank machine folder and run it to see it in action which will verify that you’ve got everything working properly.)

To run this sample config, you can run `mpf both`.

When you run it, do not use the `-x` or `-X` options, because either of those will tell MPF to not use physical hardware which means it won’t try to connect to the Teensy.

Note that the [Using a traditional \(single color\) physical DMD](#) guide has more details on the window and slide settings used in this machine config.

```
hardware:
  platform: fast
  driverboards: fast
  ports: com3, com4, com5 # be sure to change this to your actual ports

displays:
  window: # on screen window
    width: 600
    height: 200
  dmd: # source display for the DMD
    width: 128
    height: 32
    default: true

window:
  width: 600
  height: 200
```



```

title: Mission Pinball Framework

physical_dmds:
  my_dmd:
    brightness: 1.0

slides:
  window_slide_1: # slide we'll show in the on-screen window
  - type: dmd # this widget shows the DMD content in this slide too
    width: 512
    height: 128
    pixel_color: ff5500 # makes on-screen pixels the classic DMD orange
  - type: text
    text: MISSION PINBALL FRAMEWORK
    anchor_y: top
    y: top-3
    font_size: 30
  - type: rectangle
    width: 514
    height: 130
    color: 444444
  dmd_slide_1: # slide we'll show on the physical DMD
  - type: text
    text: IT WORKS!
    font_size: 30

slide_player:
  init_done:
    window_slide_1:
      target: window
    dmd_slide_1:
      target: dmd

```

How to configure an RGB DMD (FAST Pinball)

Related Config File Sections

<i>physical_rgb_dmds:</i>

If you would like to drive the RGB LED DMD via a FAST sonboard, follow the instructions for the [*RGB.DMD Controller*](#).

How to configure servos (FAST Pinball)

Related Config File Sections

<i>servos:</i>

You can drive servos from any FAST IO board by adding the FAST Servo Controller daughter board to it. You then configure and use the servos like normal. The only real “FAST-specific” thing is the number.

number:

The number of the servo requires a bit of math. Each FAST IO board “reserves” six slots for daughter board accessories (regardless of whether there’s a daughter board there are not). So the numbers go like this:

- First board in the chain (Board 0), numbers 0, 1, 2, 3, 4, 5
- Second board in the chain (Board 1), numbers 6, 7, 8, 9, 10, 11
- Third board in the chain (Board 2), numbers 12, 13, 14, 15, 16, 17
- Fourth board in the chain (Board 3), numbers 18, 19, 20, 21, 22, 23
- etc.

So to figure out the number for your servo, first figure out which board it’s plugged into, then look at which connection on that board it uses, then figure out the number based on the list above.

By default, standalone numbers like this have to be entered in hex format, so once you find your number, enter it as the hex equivalent:

Regular	Hex
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	a
11	b
12	c
13	d
14	e
15	f
16	10
17	11
18	12
19	13
20	14
21	15
22	16
23	17

If you don’t want to mess with all this hex stuff, you can set the config number format to “int” via the `fast: config_number_format:` setting. See the [fast:](#) section of the config file reference for details.

How to configure Multimorphic (P-ROC & P3-ROC) hardware

Here's a list of all the How To guides which explain how to use MPF with [Multimorphic P-ROC and P3-ROC control systems](#). These guides include the numbering format (how you map specific entries in your config files to board and connector locations) as well as overall settings that affect how your hardware performs.

3 steps to using a P-ROC/P3-ROC

1. *Install the hardware drivers to support the P-ROC/P3-ROC.*
2. *Configure your platform.*
3. Configure the individual pinball mechanisms from the list below.

P-ROC/P3-ROC pinball mech configuration

The following pinball mechanisms are supported by the P-ROC and/or P3-ROC. Click each one for details on how to configure these types of mechanisms for the P-ROC or P3-ROC.

How to use install drivers for the P-ROC / P3-ROC

Using a P-ROC or P3-ROC with MPF is pretty straightforward. The first step is to download and install the hardware drivers and libraries for your OS that the P-ROC/P3-ROC needs to communicate with your computer. The exact process for that is OS-specific, so click the link to follow the guide for your specific OS:

How to install P-ROC / P3-ROC drivers on Windows (32-bit)

This guide explains how to install the USB drivers for the P-ROC or P3-ROC on 32-bit Windows (x86).

1. Download and install the FTDI drivers

The P-ROC and P3-ROC boards use a chip from a company called "FTDI Chip" to handle the USB communication, so you need to install the FTDI driver so Windows can properly see the device when you plug it in.

You can download the latest version from here:

<http://www.ftdichip.com/Drivers/D2XX.htm>

Here's a screen shot of the download section of that page. Note that the actual version number of the driver might be newer than the screen shot below. That should be ok.

Currently Supported D2XX Drivers:

Operating System	Release Date	Processor Architecture					Comments
		x86 (32-bit)	x64 (64-bit)	ARM	MIPS	SH4	
Windows*	2016-10-10	2.12.24	2.12.24	-	-	-	WHQL Certified. Includes VCP and D2XX. Available as a setup executable . Please read the Release Notes and Installation Notes .
Windows RT	2014-07-04	-	-	1.0.2	-	-	A guide to setting up Windows RT (AN_271) is available here .
Linux	2015-08-21	-	1.3.6	1.3.6 ARMv5 soft-float 1.3.6 ARMv5 soft-float uClibc 1.3.6 ARMv6 hard-float (suits Raspberry Pi) 1.3.6 ARMv7 hard-float	1.3.6 MIPS32 soft-float 1.3.6 MIPS32 hard-float	-	If unsure which ARM version to use, compare the output of <code>readelf</code> and <code>file</code> commands on a system binary with the content of <code>release/build/libftd2xx.txt</code> in each package. ReadMe
Mac OS X 10.4 Tiger or later	2012-10-30	1.2.2	1.2.2	-	-	-	If using a device with standard FTDI vendor and product identifiers, install D2xxHelper to prevent OS X 10.11 (El Capitan) claiming the device as a serial port (locking out D2XX programs). ReadMe
...	1.0.1.6

Download and run the setup executable from the “1” link in the screen shot. (We like to use that because it’s easier than the manual process you get from using the “2” link in that screen shot.)

Now MPF will be able to communicate with the P-ROC or P3-ROC.

Continue on with the [How to configure MPF for the P-ROC/P3-ROC platform](#) documentation to finish your MPF configuration for the P-ROC/P3-ROC.

How to install P-ROC / P3-ROC drivers on Windows (64-bit)

This guide explains how to install the USB drivers for the P-ROC or P3-ROC on 64-bit Windows (x64).

1. Download and install the FTDI drivers

The P-ROC and P3-ROC boards use a chip from a company called “FTDI Chip” to handle the USB communication, so you need to install the FTDI driver so Windows can properly see the device when you plug it in.

You can download the latest version from here:

<http://www.ftdichip.com/Drivers/D2XX.htm>

Here’s a screen shot of the download section of that page. Note that the actual version number of the driver might be newer than the screen shot below. That should be ok.

Download and run the setup executable from the “1” link in the screen shot.

Currently Supported D2XX Drivers:

Operating System	Release Date	Processor Architecture					Comments
		x86 (32-bit)	x64 (64-bit)	ARM	MIPS	SH4	
Windows*	2016-10-10	2.12.24	2.12.24	-	-	-	WHQL Certified. Includes VCP and D2XX. Available as a setup executable . Please read the Release Notes and Installation Notes .
Windows RT	2014-07-04	1.0.2		1.0.2	-	-	A guide to selecting a driver (AN_271) is available here .
Linux	2015-08-21	1.3.6		1.3.6 ARMv5 soft-float 1.3.6 ARMv5 soft-float uClibc 1.3.6 ARMv6 hard-float (suits Raspberry Pi) 1.3.6 ARMv7 hard-float	1.3.6 MIPS32 soft-float 1.3.6 MIPS32 hard-float	-	If unsure which ARM version to use, compare the output of <code>readelf</code> and <code>file</code> commands on a system binary with the content of <code>release/build/libftd2xx.txt</code> in each package. ReadMe
Mac OS X 10.4 Tiger or later	2012-10-30	1.2.2	1.2.2	-	-	-	If using a device with standard FTDI vendor and product identifiers, install D2xxHelper to prevent OS X 10.11 (El Capitan) claiming the device as a serial port (locking out D2XX programs). ReadMe
...					1.0.1.6		

2. Now download and unzip the other package

Next you need to download the other package (from the “2” link in the screen shot) which is a zip file.

Unzip it and find the file called `ftd2xx64.dll`. (Probably in the `amd64` folder.)

Copy it to `C:\Windows\System32`

Rename it from `ftd2xx64.dll` to `ftd2xx.dll`

Now MPF will be able to communicate with the P-ROC or P3-ROC.

Continue on with the [How to configure MPF for the P-ROC/P3-ROC platform](#) documentation to finish your MPF configuration for the P-ROC/P3-ROC.

How to install P-ROC / P3-ROC drivers on Mac OS

Installing the P-ROC drivers (`libpinproc` and `pypinproc`) on the Mac is a manual process that requires a few prerequisites and some supporting software. We chose to use the [homebrew](#) package manager to help us with the install, which is similar to the `apt-get` package manager in Linux. The following instructions will help you get `homebrew` installed, along with everything else.

These instructions assume you have already installed MPF.app. If you haven't, you will need to [go back and do that first](#), since it has to be installed before you can build the P-ROC drivers.

1. Install Brew

Open a Terminal and paste in the following commands (and then press <Enter> after each one):

```
cd /usr/local  
/usr/bin/ruby -e "$(curl -fsSL https://raw.githubusercontent.com/Homebrew/install/master/install)"
```

If you're prompted to install Xcode, click Install, followed by Agree.

After Xcode installs (or right away if you already had it), press Return to continue and then enter your password.

You'll see a bunch of stuff scroll by as things are downloaded and installed.

2. Create a folder in your user folder called "proc"

From the same terminal window, run:

```
mkdir ~/proc
```

3. Download osx-proc-support

Change to that new folder:

```
cd ~/proc
```

And run the following command which will clone (download) the files you need to make the P-ROC run on the Mac. (Even though this is called "osx-proc-support", it also works with MacOS Sierra.)

```
git clone https://github.com/missionpinball/osx-proc-support
```

4. Install prerequisites via Brew

Now run:

```
brew install libftdi libusb-compat cmake
```

5. Install yaml-cpp

The P-ROC/P3-ROC requires a library called yaml-cpp. While there is a yaml-cpp package in brew, it's too new to use here. Adding to the fuss is that the version we need is no longer available, so we included it on the osx-proc-support package that you downloaded earlier.

Run the following commands to compile it from scratch:


```
cd ~/proc/osx-proc-support
tar -xzf yaml-cpp-0.2.5.tar.gz
cd yaml-cpp-0.2.5
mkdir bin
cd bin
cmake ..
make
sudo make install
```

6. Download & install libpinproc

Libpinproc is the P-ROC/P3-ROC library that lets the host computer talk to the P-ROC/P3-ROC hardware. Run the following commands:

```
cd ~/proc
git clone --branch=master https://github.com/preble/libpinproc
```

Copy the Mac version of CMakeLists.txt to the libpinproc folder:

```
cp -r ~/proc/osx-proc-support/CMakeLists.txt ~/proc/libpinproc
```

That avoids having to edit the file manually. It should work for nearly all situations, but if libpinproc won't compile in the next steps, you should make sure the paths in include_dirs within CMakeLists.txt are correct.

```
cd libpinproc
mkdir bin
cd bin
cmake -DBUILD_SHARED_LIBS=ON ..
make
sudo make install
```

7. Download & install pypinproc 2.1

Pypinproc is a wrapper library that allows Python apps (like MPF) to talk to the libpinproc that you installed in the previous step. Unfortunately the version that is available from the pinballcontrollers.com website only works with Python 2.x, and MPF uses Python 3.x, so you have to download a version that we modified to work with Python 3:

```
cd ~/proc
git clone https://github.com/missionpinball/pypinproc
cd pypinproc
python3 setup.py build
sudo python3 setup.py install
```

8. Install D2xxHelper

D2xxHelper is provided by FTDI Chips, the maker of the chip which acts as the USB interface on the P-ROC/P3-ROC boards. Mac OS comes with its own FTDI driver that's loaded by default and prevents other FTDI drivers from running. D2xxHelper adjusts the priorities of FTDI driver loading so that the

FTDI driver we need loads first, preventing the Apple FTDI driver from loading. This is Apple Support’s recommended method of solving the problem, so you’re safe:

```
cd ~/proc/osx-proc-support
sudo installer -pkg D2xxHelper_v2.0.0.pkg -target /
```

9. Reboot

You have to reboot in order to have the changes D2xxHelper made take effect. After that, you should be all set and can continue on with the [How to configure MPF for the P-ROC/P3-ROC platform](#) documentation to finish your MPF configuration for the P-ROC/P3-ROC.

How to install P-ROC / P3-ROC drivers on Linux

If you want to use MPF on a Debian-based version of Linux (which includes Ubuntu), you can use our all-in-one Debian installer which is detailed in the [Installing MPF on Linux](#) guide.

Note that when you run that installation script, it will ask you what type of hardware you’ll be using. If you choose the “P3 or P-ROC” option, then it will install all of the libraries and drivers you need, and everything should work.

After that, you can continue on with the [How to configure MPF for the P-ROC/P3-ROC platform](#) documentation to finish your MPF configuration for the P-ROC/P3-ROC.

How to configure MPF for the P-ROC/P3-ROC platform

Related Config File Sections
hardware:
p_roc:
p3_roc:

Once you have your [P-ROC/P3-ROC drivers installed](#), you need to configure your machine to use the P-ROC or P3-ROC.

1. Set your platform

In your machine-wide config file, set the platform.

For the P-ROC:

```
hardware:
  platform: p_roc
```

For the P3-ROC:

```
hardware:
  platform: p3_roc
```


2. Set your driver boards:

Next, configure the driver boards setting which tells MPF which type of driver boards you're using. If you're using the P-ROC driver boards (like the PD-16 or PD-8x8), then you set it like this:

For the P-ROC:

```
hardware:
  platform: p_roc
  driverboards: pdb
```

For the P3-ROC:

```
hardware:
  platform: p3_roc
  driverboards: pdb
```

Note that if you're using a P-ROC with an existing machine, then your driver boards will be either wpc, stern, etc. See the documentation on configuring MPF for use in existing machines for details. (link TODO)

3. Configure your watch dog timeout

The P-ROC has the ability to use a [watch dog](#) timer. This is enabled by default with a timeout of 1 second. If you would like to disable this, or you'd like to change the timeout, you can do so in either the `p_roc:` or `p3_roc:` section of your machine-wide config.

For the P-ROC:

```
p_roc:
  use_watchdog: true
  watchdog_time: 1s
```

For the P3-ROC:

```
p3_roc:
  use_watchdog: true
  watchdog_time: 1s
```

How to configure switches (P-ROC)

Related Config File Sections

switches:

To configure switches on a P-ROC, you can follow the guides and instructions in the [Switches](#) docs.

However there are a few things to know about using switches with a P-ROC.

number:

Switches are directly connected to the P-ROC board itself. There are two types of switches—matrix and direct—and they each have a different number format.

Note: If you're using your P-ROC in an existing machine, then don't use the number settings here. Instead use the numbers from the existing machine section of the documentation. (link TODO)

Direct Switches

The P-ROC has 32 direct switch inputs (which are switches that are directly connected to the P-ROC that do not require a switch matrix). Direct switches are numbered 0-31. (See the P-ROC documentation for the connector mappings.)

Direct switches are configured in your machine config file by starting the number with "SD", like this:

```
switches:
  my_switch:
    number: SD0
  my_other_switch:
    number: SD1
  another_switch:
    number: SD12
```

Matrix Switches

If you're using a switch matrix, then the switch numbers are entered using the column number, then a slash, then the row number.

```
switches:
  my_switch:
    number: 0/0 # column 0, row 0
  my_other_switch:
    number: 0/1 # column 0, row 1
  another_switch:
    number: 3/4 # column 3, row 4
```

Mixing and matching direct and matrix switches

You can mix-and-match direct and matrix switches. However you should be aware of the hardware limitations of combining both. The P-ROC gives you the ability for ONE of the following:

- 32 direct switches and an 8x8 (64 switches) matrix
- 24 direct switches and an 8x16 (128 switches) matrix

Basically the P-ROC has the ability to repurpose 8 of the direct switch inputs as row inputs to extend the switch matrix from 8 to 16 rows. This means that valid values are:

- Direct switches, SD0 - SD31

- Matrix switches, 0/0 - 7/7

OR

- Direct switches, SD8 - SD31
- Matrix switches, 0/0 - 7/15

In other words, if any switch uses a row number (the number after the slash) greater than 7, then you can't use direct switches 0 through 7.

The configuration of this is automatic based on the numbers you use, but currently there is no error checking to ensure that SD0 - SD7 are not used if you have any switch which a row that's 8-15.

Choosing direct versus matrix switches

The only difference between direct and matrix switches is in how they're wired. Matrix switches use less wire, but require diodes on the switches and are harder to troubleshoot. Direct switches are easier to wire, but they require more wire and you're limited to 24 (or 32) of them.

If you're using *opto switches* then you must connect the IR receivers to direct switch inputs, since the direct switch inputs are always powered.

There's a misconception that direct switches are "faster" than matrix switches. That is false. The P-ROC scans the 8 columns of the matrix (one at a time), then it reads the direct switches, then the matrix switches again, then the directs, etc. So from a practical sense, the directly switches are really like a single column matrix with either 24 or 32 rows, and they're scanned after the rows of the matrix are scanned. So whether a switch is direct or in the matrix doesn't affect the scanning speed or response time of the switch.

Debounce options

The P-ROC has the ability to configure *debounce settings* for switches. A non-debounced switch which report its state change immediately, while a debounced switch will report its state change after it's been in the new state for two consecutive reads.

By default, MPF will enable debouncing in both directions (open and close) for all switches. However you can override this on a per-switch basis with a switch's `debounce:` setting.

Valid options are `normal`, `quick`, and `auto`.

To disable debouncing for a switch, add `debounce: quick` to the switch config, like this:

```
switches:
  my_switch:
    number: 0/0
    debounce: quick
```

To force debouncing to always be used (which is also the default on the P-ROC, so not really needed), configure it like this:

```
switches:
  my_switch:
    number: 0/0
    debounce: normal
```


How to configure switches (P3-ROC)

Related Config File Sections

<i>switches:</i>

To configure switches on a P3-ROC, you can follow the guides and instructions in the [Switches](#) docs. However there are a few things to know about using switches with a P3-ROC.

number:

Unlike the P-ROC, the P3-ROC does not have switch inputs on the P3-ROC itself. Instead, you add SW-16 boards which each have 16 direct switch inputs. (e.g. there is no switch matrix.) You can connect up to 16 SW-16s to support as many as 256 switches.

To configure the number: of a switch connected to an SW-16 board and a P3-ROC, you have two options.

The first (and easier) option is to enter the number as a combination of the SW-16 board address (0-15, as configured by the DIP switches), then the bank number (A=0, B=1), then the switch number (0-7).

For example:

```
switches:
  my_switch:
    number: 0/0/0 # SW-16 board at address 0, Bank A, Switch 0
  my_other_switch:
    number: 2/1/5 # SW-16 board at address 2, Bank B, Switch 5
```

Debounce options

The P-ROC has the ability to configure [debounce settings](#) for switches. A non-debounced switch which report its state change immediately, while a debounced switch will report its state change after it's been in the new state for two consecutive reads.

By default, MPF will enable debouncing in both directions (open and close) for all switches. However you can override this on a per-switch basis with a switch's `debounce:` setting.

Valid options are normal, quick, and auto.

To disable debouncing for a switch, add `debounce: quick` to the switch config, like this:

```
switches:
  my_switch:
    number: 0/0/0
    debounce: quick
```

To force debouncing to always be used (which is also the default on the P-ROC, so not really needed), configure it like this:

```
switches:
  my_switch:
```



```
number: 0/0/0
debounce: normal
```

How to configure coils/drivers/magnets (P-ROC/P3-ROC)

Related Config File Sections

[coils:](#)

To configure coils, drivers, motors, and/or magnets (basically anything connected to PD-16 board's driver outputs) with P-ROC/P3-ROC hardware, you can follow the guides and instructions in the [Coils \(Solenoids\)](#) docs.

(If you're using a P-ROC with an existing machine's driver board, like a WPC machine, then see the existing machine documentation. [Link TODO](#))

The only specific thing you have to know for this platform is the number format:

number:

For PD-16-based devices, the numbering format is:

```
number: Ax-By-z
```

The "A" and "B" capital letters are required. (A means Address, B means Bank). The lowercase x, y, and z letters should be replaced with numbers to represent the following on a PD-16 driver board:

- x : Board address (0-31)
- y : Bank address (0 for A, 1 for B)
- z : Output number (0-7)

Note: The output number is the logical number, *not* the pin number. For example, Output 0 is on Pin 1, and there is a key pin at 2 or 3. Check the manual for the exact mapping.

For example:

```
coils:
  some_coil:
    number: A0-B1-6
    pulse_ms: 30
```

Fine tuning hold power

When using the P-ROC or P3-ROC, you can fine tune a coils hold power setting.

First, you're able to use `hold_power:` (with a value 0-8) as described in the [Adjust coil hold power](#) documentation.

However, instead of using `hold_power:`, you can alternately configure a repeating pattern of “on” and “off” times, specified in milliseconds, via `pwm_on_ms:` and `pwm_off_ms:` settings, like this:

```
coils:
  some_coil:
    number: A0-B1-6
    pwm_on_ms: 2
    pwm_off_ms: 2
```

Then if that coil is enabled (held on), it will be on for 2ms, then off for 2ms, then repeat.

Notes:

- This only affects coils that are held on. Pulse actions will always be at 100%.
- If you configure a `hold_power:` setting, it will take precedence over the `pwm_on_ms:` and `pwm_off_ms:` settings, so don't configure both.
- When you configure these settings, you do not need the `allow_enable: true` setting.

How to configure LEDs (P-ROC/P3-ROC)

Related Config File Sections
leds:

This guide explains how to configure MPF to use LEDs attached to a Multimorphic PD-LED board with either a P-ROC or P3-ROC.

Note that if you're using a P-ROC/P3-ROC and you want to use serial-controlled LEDs (NeoPixels, etc.), then you can do that with a P-ROC/P3-ROC by using a [FadeCandy](#) instead of a PD-LED. You can also mix-and-match PD-LEDs and FadeCandy LEDs.

Understanding the PD-LED board

The PD-LED controls up to 84 individual LED elements, which can be used to control individual single color LEDs, or (more likely), combined into groups to control RGB LEDs.

The PD-LED uses a “direct” connection method for LEDs, where each LED has connections for each color element running back to the PD-LED. This is a different architecture than the serial-controlled “Neo Pixel” type LEDs that other hardware uses.

LED number:

Since the PD-LED board directly drives single color LED outputs, when you use it with RGB LEDs, you combine three outputs into a single RGB LED. The PD-LED supports both common cathode (common ground) and common anode (common 3.3v) LEDs, so each LED you buy has four pins (red, green, blue, and common). When you configure the hardware number for a PD-LED RGB LED, you specify four parts, separated by dashes:

1. The address of the PD-LED board on the serial chain (as configured via the DIP switches on the PD-LED).
2. The output number of the red element.

3. The output number of the green element.
4. The output number of the blue element.

You separate those with dashes, so an example PD-LED configuration might look like this:

```
leds:
  l_led0:
    number: 8-0-1-2
```

The example above configures “l_led0” as the LED connected to PD-LED board at address 8, using outputs 0, 1, and 2 as its red, green, and blue connections.

polarity:

The PD-LED allows you to use either common anode or common cathode LEDs. (See the PD-LED documentation for details. The type of LED would dictate whether you hook it up between the PD-LED’s output and ground, or between the output and 3.3v.) You can then use the config file to specify which type of LED you have, such as:

```
leds:
  l_shoot_again:
    number: 8-60-61-62
    polarity: True
```

True = common cathode (or common ground), **False** = common anode (or common 3.3V)

Note that DIP Switch 6 on the PD-LED board controls whether the “default” state of the LEDs after a reset is high or low. Basically it’s whether all the LEDs turn on or turn off when the board is reset. Which position does what is dependent on whether you’re controlling the anode or the cathode with your outputs, so basically if you turn on your PD-LED and all your LEDs turn on, then flip DIP switch 6 on the PD-LED to the opposite position and power cycle the board.

How to configure Matrix Lights (P-ROC/P3-ROC)

Related Config File Sections
<i>matrix lights:</i>
<i>p_roc:</i>
<i>p3_roc:</i>

To configure matrix lights connected to a PD-8x8 and a P-ROC or P3-ROC, you can follow the guides and instructions in the [*Lights*](#) docs.

However there are a few things to know about using matrix lights with a P3-ROC.

Note: If you’re using your P-ROC in an existing machine, then don’t use the number settings here. Instead use the numbers from the existing machine section of the documentation. (link TODO)

number:

Configure the number for each lamp in your `matrix_lights:` section with an entry that contains a bunch of letters and numbers which specify the specific columns and row outputs that make up each lamp. It's probably easiest to look at an example.

```
matrix_lights:
  some_light:
    number: C-A2-B0-0:R-A2-B1-0
```

Notice there are two parts to the number, separated by a colon.

The first part is the column information:

- C means "Column"
- A2 means "the PD-8x8 at Address 2"
- B0 means "Bank 0"
- 0 means output "0"

The second part is the row information:

- R means "Row"
- A2 means "the PD-8x8 at Address 2"
- B1 means "Bank 1"
- 0 means input "0"

Luckily this is only something you have to work out once. :)

Fine tuning column strobe times

The lamp matrix works by quickly cycling through the columns and then activating the rows for the individual lamps that are supposed to be on in that specific column.

Back in the day when only incandescent bulbs were used, this pretty much worked the same everywhere and you didn't have to worry about any other settings. However now that it's possible to use LEDs replacement bulbs in your lamp matrices, and there are all sorts of LEDs like "anti-ghosting" and things like that, you may want to fine-tune the timing of how the columns are activated. You can do that in the `p_roc:` or `p3_roc:` sections of your machine-wide config.

For P-ROC:

```
p_roc:
  lamp_matrix_strobe_time: 100ms
```

For P3-ROC:

```
p3_roc:
  lamp_matrix_strobe_time: 100ms
```

100ms is the default setting (which is used if you don't add this entry), but you can play with this value to see how it affects your lights or LEDs.

This is a system-wide setting, so if you have multiple lamp matrices on multiple PD-8x8 boards, then this setting will be used for all of them.

How to configure mono/traditional DMD (P-ROC)

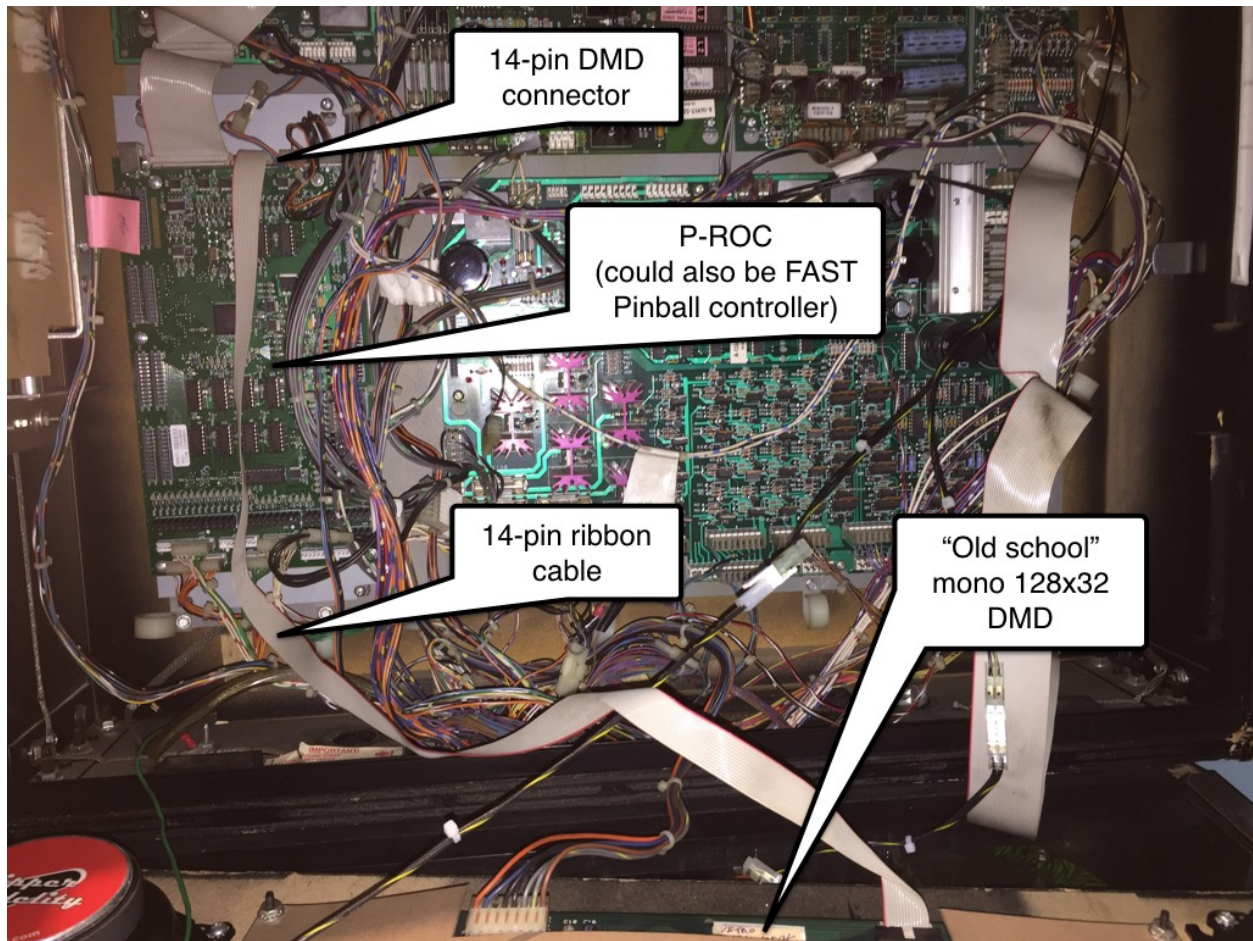
Related Config File Sections
<i>physical_dmds:</i>
<i>p_roc:</i>

The P-ROC can drive a traditional single-color pinball DMD via the 14-pin DMD connector cable that's been in most pinball machines for the past 25 years, like this:



Note: If you want to drive an RGB LED DMD and you're using a P-ROC, you can do that by adding a [*SmartMatrix*](#) or [*RGB.DMD*](#) board which you would then use in place of the P-ROC's 14-pin DMD connector.

1. Connect your hardware



2. Add a physical DMD device entry

Once you have your hardware and port set, you need to create the actual device entry for the DMD.

You do this in the `physical_dmds:` section of the machine config. This section is like the other common sections (switches, coils, etc.) where you enter the name(s) of your device(s), and then under each one, you enter its settings.

(And yes, in case you're wondering, it's possible to have more than one physical DMD.)

To do this, create a section in your machine-wide config called `physical_dmds:`, and then pick a name for the DMD, like this:

```
physical_dmds:
  my_dmd:
    shades: 16
```

You need to have at least one setting for this to be a valid YAML file, so we usually just pick the shades and add that with a value of 16 (which means the DMD runs will convert the display content to 16 mono shades when it displays it).

The “shades” option is how many brightness shades you want. 1990s WPC machines supported 4 shades, and modern Stern DMD machines support 16. The P-ROC supports 16 shades (even on older 1990s plasma DMDs). Most modern games will probably be 16 shades, but you can do 4 (or even 2) if you want an old school look.

There are lots more options for the `physical_dmd:` section than just the “shades” option listed here. Check the [physical_dmds:](#) for a list of all the options.

Note that one option you do NOT have for physical DMDs is the color. That’s because the color of the DMD is determined by the DMD itself. You don’t actually send it color values, rather, you just send it brightness levels, and the DMD shows those brightness levels with whatever color the DMD is.

3. Set a source display

Now that you have everything configured, the last step is to make sure the DMD knows what content to show. In MPF, you do this by mapping a physical DMD to an [MPF display](#).

By default, the DMD will look for a display (in your [displays:](#) section called “dmd”. However you can override this and configure the DMD to use whatever logical display you want by setting a `source_display:` setting. (Just make sure that the width and height of your source display match the physical pixel dimensions of the DMD or else it will be weird.)

4. Setting the DMD update rate

By default, MPF will send new DMD frames to the P-ROC at about 30 frames per second. (Technically it sends a new frame every 33ms.)

5. Fine tuning the DMD timing cycles

The P-ROC is able to drive a traditional DMD with 16 shades of intensity, ranging from off (0) to full on (15). Note that the P-ROC doesn’t control (or even know) what color the DMD is as that’s dictated by the DMD itself.

The P-ROC creates the appearance of 16 levels of brightness by rapidly turning individual dots on and off.

For years, DMD’s have been high-voltage gas plasma displays, though more recently they’re LED-based (even the single color ones with the 14-pin connectors).

Some people have reported less-than-optimal quality when using a P-ROC with certain types of DMDs. To address this, the P-ROC allows you to fine-tune the timings of the individual [bit planes](#) that make up the image.

For details on this, you can search the [P-ROC forums](#) for “high_cycles” to find a few threads where people are talking about these settings. Then you can set them in the `p_roc: dmd_timing_cycles:` section of your machine-wide config, like this:

```
p_roc:
  dmd_timing_cycles: 90, 190, 50, 377
```

Note that we do not have specific recommendations for values here and based on our experience, we haven’t found a need to change this. However, if you do have issues and you get new values by talking to the P-ROC folks, this is how you adjust them in MPF.

Our recommendation is that you leave the `dmd_timing_cycles`: setting out of your `p_roc`: config unless you need it and really know what you're doing. (There's potential that bad values here could permanently damage your DMD hardware, so again, only change these if you know what you're doing.)

A final config you can test

At this point you're all set, and whatever slides and widgets are shown on the DMD's source display in MPF-MC should be shown on the physical DMD.

That said, all these options can be kind of confusing, so we created a quick example config you can use to make sure you have yours set right. (You can actually just save this config to `config.yaml` in a blank machine folder and run it to see it in action which will verify that you've got everything working properly.)

To run this sample config, you can either run `mpf both`.

When you run it, do not use the `-x` or `-X` options, because either of those will tell MPF to not use physical hardware which means it won't try to connect to the Teensy.

Note that the [Using a traditional \(single color\) physical DMD](#) guide has more details on the window and slide settings used in this machine config.

```
hardware:
  platform: p_roc
  driverboards: pdb

displays:
  window: # on screen window
    width: 600
    height: 200
  dmd: # source display for the DMD
    width: 128
    height: 32
    default: true

window:
  width: 600
  height: 200
  title: Mission Pinball Framework

physical_dmds:
  my_dmd:
    brightness: 1.0

slides:
  window_slide_1: # slide we'll show in the on-screen window
    - type: dmd # this widget shows the DMD content in this slide too
      width: 512
      height: 128
      pixel_color: ff5500 # makes on-screen pixels the classic DMD orange
    - type: text
      text: MISSION PINBALL FRAMEWORK
      anchor_y: top
      y: top-3
      font_size: 30
```



```

- type: rectangle
  width: 514
  height: 130
  color: 444444
dmd_slide_1: # slide we'll show on the physical DMD
- type: text
  text: IT WORKS!
  font_size: 30

slide_player:
  init_done:
    window_slide_1:
      target: window
    dmd_slide_1:
      target: dmd

```

How to configure an RGB DMD (P-ROC/P3_ROC)

Related Config File Sections
<i>physical_rgb_dmds:</i>
<i>smartmatrix:</i>

Neither the P-ROC nor the P3-ROC has direct support for RGB DMDs. However you can still use an RGB DMD with a P-ROC/P3-ROC by using one of the standalone RGB DMD controllers. (Basically you buy the RGB DMD hardware and another small controller, and then you have two USB connections from your computer—one to the P-ROC/P3-ROC, and a second to the RGB DMD controller.)

Standalone RGB DMD options which you can use with a P-ROC/P3-ROC include:

- [*SmartMatrix*](#)
- [*RGB.DMD*](#)

How to configure alpha-numeric displays (P-ROC)

The P-ROC includes support for alpha-numeric displays. However MPF does not support these yet.

When we do add alpha-numeric display support, you will be able to use the P-ROC to drive them.

How to configure the accelerometer (P3-ROC)

Related Config File Sections
<i>accelerometers:</i>

The P3-ROC includes an accelerometer which you can use with MPF to detect g-force changes (to use as a tilt) as well as 3-axis leveling (to use to determine whether the machine is level).

To use the accelerometer on the P3-ROC, add it to your machine-wide config file like this:


```
accelerometers:
  p3_roc_accelerometer:
    number: 1
```

The name (which is “p3_roc_accelerometer” in the example above) doesn’t really matter, but it has to be number: 1.

Other than that, use it like you would any accelerometer in MPF, by following the docs and guides in the [Accelerometers](#) section of the documentation.

How to configure servos (P3-ROC)

Related Config File Sections

servos:

The P3-ROC contains an I2C port (J17) which is accessible to MPF. You can use this port to control an I2C-based servo. (You can’t plug the servo directly into the P3-ROC, rather, you can buy an I2C-based servo controller and plug it into the P3-ROC.)

You need to connect SDA, SCL and ground. You may not need the 3.3V from the P3-ROC as your controller might be a different voltage (which you can then get directly from your power supply), but again that depends on the board.

See the [I2C Servo Controllers](#) documentation for details on how to configure this.

If you want to use this with a P3-ROC, you can configure it in your machine config it similar to this:

```
hardware:
  driverboards: pdb
  platform: p3_roc
  servo_controllers: i2c_servo_controller

servo_controller:
  address: 0x40

servos:
  servo1:
    number: 3
```

The address and number of your servo and servo controller can be found in the documentation of your controller and are most likely configurable. You can also connect multiple I2C servo controllers to the P3-ROC by configuring them with unique I2C addresses.

How to configure Open Pinball Project (OPP) hardware for MPF

This how to guide explains how to set up your MPF configuration files to interface with an Open Pinball Project (OPP) pinball controller.

Configuring your machine for OPP

1. Configure the Hardware platform for OPP

To use MPF with OPP, you need to configure your platform as *opp*, like this:

```
hardware:
  platform: opp
  driverboards: gen2
```

You also need to configure the `driverboards:` entry for what kind of driver boards you're controlling: right now, only *gen2* is supported.

2. Configure the OPP-specific hardware settings

When you use OPP hardware with MPF, you also need to add an `opp:` section to your machine-wide config which contains some OPP-specific hardware settings. MPF's default config file (*mpfconfig.yaml*) contains enough default settings to get you up and running. The only thing you absolutely have to configure is your ports.

Understanding OPP hardware ports

Even though OPP controllers are USB devices, they use "virtual" COM ports to communicate with the host computer running MPF. On your computer, if you look at your list of ports and then plug-in your OPP controller, you will see a new port appear. The exact names and numbers of these ports will vary depending on your computer and what else you've plugged in in the past.

Note: USB to serial converters add latency when communicating between the host computer, and the target device. It probably will not matter, but if given the choice between a "real" serial port, and a USB-serial port converter, the "real" serial port will have less latency. The real serial port must use 5V signal levels when talking to OPP hardware.

Adding the port to your config file

If you're using an OPP controller, you need to add the serial port to your MPF config. So if you plug in the OPP controller and see a port such as *COM7* appear, you'd set your config like this:

```
opp:
  ports: COM7
```

Full details of the port options as well as the other options available here are in the `opp:` section of the configuration file reference. Note that if you're using Windows and you have COM port numbers greater than 9, you may have to enter the port names like this: `\\.\COM10` `\\.\COM11` `\\.\COM12`, etc. (It's a Windows thing. Google it for details.) That said, it seems that Windows 10 can just use the port names like normal: `com10`, `com11`, `com12`, so try that first and then try the alternate format if it doesn't work.

Changing the polling rate

If you encounter issues with the polling rate (in other words: Your OPP processor boards can't answer MPF's polls fast enough) you may want to change it. (Default: 100Hz) This can be done by simply adding the `poll_hz:` line to the `opp:` section:

```
opp:
  ports: COM7
  poll_hz: 50
```

Note: You only want to do this if you encounter issues. This will increase the time between two switches being read. Depending on the number of processor boards in your chain you could possibly miss some fast balls

OPP Switches

For switches, you can use most of the settings as outlined in the `switches:` section of the config file reference. There are only a few things that are OPP-specific:

Number:

OPP switches are numbered sequentially depending on which wing board is the switch input. Wing position 0 contains switch numbers 0 to 7. Wing position 1 contains switch numbers 8 to 15. Wing position 2 contains switch numbers 16 to 23. Wing position 3 contains switch numbers 24 to 31. The switch is numbered using the position of the OPP card (starting at 0), then a '-', and finally the switch number on the card.

Enter them as a combination of board-switch, like 0-12.

```
switches:
  some_switch:
    number: 0-15
```

The above example configures a switch input as the first OPP card, and the second wing board, last input. On the microprocessor card, the input is marked as 1.7 (wing port 1, position 7).

Switch inputs for solenoids follow the same number convention. Since only four inputs are available for each wing card, it uses the first four switch numbers. Solenoid wing 0 uses switch numbers 0 to 3. Solenoid wing 1 uses switch numbers 8 to 11. Solenoid wing 2 uses switch numbers 16 to 19. Solenoid wing 3 uses switch numbers 24 to 27.

Switch inputs for a switch matrix are number slightly differently. To configure an 8x8 switch matrix wing 2 is configured as the matrix input and wing 3 is configured as a matrix output. The OPP hardware strobes the eight outputs while reading from the eight inputs. This allows 64 inputs to be read using only 16 wires. The matrix switch inputs are numbered from 32 to 95. Switches 32 - 39 are column 0, switches 40 - 47 are column 1, switch 48 - 55 are column 2, switches 56 - 63 are column 3, switches 64 - 71 are column 4, switches 72 to 79 are column 5, switches 80 to 87 are column 6, and switches 88 to 95 are column 7.

OPP coils / drivers

There are a few things to know about controlling drivers and coils with OPP hardware.

Number

OPP coils are numbered sequentially depending on which wing board is the coil output. Wing position 0 contains coil numbers 0 to 3. Wing position 1 contains coil numbers 4 to 7. Wing position 2 contains coil numbers 8 to 11. Wing position 3 contains coil numbers 12 to 15. The coil is numbered using the position of the OPP card (starting at 0), then a '-', and finally the coil number on the card.

```
coils:
  some_coil:
    number: 0-12
```

The above example configures a coil output as the first OPP card, and the third wing board, first output. On the microprocessor card, the output is marked as 3.4 (wing port 3, position 4).

Pulse time

The OPP hardware also has the ability to specify the “pulse time”. Pulse time is the coil’s initial kick time. For example, consider the following configuration:

```
coils:
  some_coil:
    number: 0-12
    pulse_ms: 30
```

When MPF sends this coil a pulse command, the coil will be fired for 30ms.

Hold Power

If you want to hold a driver on at less than full power, MPF does this by using “hold_power” parameter which works for all platforms. It can range from 0 to 8 and $\text{hold_power}/8 = \text{time share the coil is on}$.

The period is fixed at 16ms for OPP. To set the hold power to 25%, set hold_power to 2 and OPP will use $4\text{ms}/16\text{ms} = 25\%$.

By using the MPF hold_power parameter you can only use 8 out of 16 possible steps. Therefore, you can also use the OPP specific parameter hold_power16 which can range from 0 to 16. If hold_power16 is 16 or more, the coil will be held on at 100% power.

```
coils:
  some_coil:
    number: 0-3
    pulse_ms: 32
    hold_power: 4
```

This will configure OPP card 0, solenoid wing 0, last solenoid to have an initial pulse of 32 ms, and then be held on at 50% power.

OPP Lights

If you're using an OPP incandescent wing card, the lights are numbered the same as the input switches. OPP bulbs are numbered sequentially depending on which wing board controls the output. Wing position 0 contains bulbs 0 to 7. Wing position 1 contains bulbs 8 to 15. Wing position 2 contains bulbs 16 to 23. Wing position 3 contains bulbs 24 to 31. The bulb is numbered using the position of the OPP card (starting at 0), then a '-', and finally the bulb number on the card.

```
matrix_lights:
  some_light:
    number: 1-16
```

The above example configures a bulb on the second OPP card, and the third wing board, first bulb. On the microprocessor card, the input is marked as 2.0 (wing port 2, position 0).

OPP LEDs

OPP hardware can directly drive LED strips. This feature is currently being developed. Documentation will be added as the feature becomes more mature.

How to use MPF with Stern SPIKE / SPIKE 2 machines

New in version 0.33.

If you haven't done so already, be sure to read the [MPF Overview](#) page to understand how MPF talks to physical pinball machines in general.

Stern pinball machines from early 2015 (Wrestlemania) onwards use a control system called SPIKE (or SPIKE 2 from Batman 66 onwards). The complete list of SPIKE machines is available in IPDB (click here for [SPIKE](#) and [SPIKE 2](#) machines).

You can read all about how SPIKE works in the operators manuals for the games, but the important thing to know here is that SPIKE machines essentially have a full linux computer inside them (the "SPIKE CPU Node") which runs the game code from an SD card.

If you want to use MPF to control or power a Stern SPIKE system, you can make some small changes to the SD card to enable external control and then connect the computer running MPF to the CPU Node via USB.

Note: When you use MPF with a Stern SPIKE machine, MPF itself does not run "on" the SPIKE CPU Node. Rather you still run MPF on a host computer (your laptop, a Raspberry Pi, a mini-ATX motherboard in the machine, etc.), and it connects to the SPIKE CPU node via a serial or USB connection to control the machine.

Doing so gives you full control of the machine. You can read the states of switches, fire coils, set LEDs, etc. Then you can use MPF to write your own game code, just like any other platform.

Note that you *cannot* access any of the existing Stern game rules, code, or assets (videos, images, sounds, etc.) All of that is compiled into the original game code on the SD card and protected by copyright. So if you just want to do a "small tweak" to the rules of a Stern SPIKE machine, then MPF is not the right tool for that. Instead MPF would be used to completely rewrite the game from scratch,

either to write a different version for the existing machine or to retheme the machine into something of your own creation.

Note: The MPF to Stern SPIKE bridge & support is new and EXPERIMENTAL. Much of this will change in the next weeks and months as we get more real world experience with it.

Warning: It's possible that using the MPF SPIKE bridge will void your warranty. For example, maybe you build a config or MPF contains a bug that holds a coil on too long and it burns up your machine. Use it at your own risk. It's also possible that you will not void your warranty. We are not lawyers and don't know.

Warning: If you break or corrupt your original SD card with your Stern game code on it, you may have to get a new one from Stern support. Again, proceed at your own risk only if you know what you're doing.

Fundamentally, using MPF with a Stern SPIKE system is like putting a P-ROC in a Williams WPC machine. All it does is expose the hardware to a computer which you can then control, and you're on your own in terms of rules and assets and code and everything. The advantage of using a SPIKE machine is you don't have to buy a \$325 P-ROC, and you can swap back-and-forth between the original rules and your own code by changing an SD card versus having to unplug and re-plug a bunch of wires to swap out a board.

Stern SPIKE features that work today

- Coils / drivers
- Switches
- LEDs & GIs
- Backbox LEDs
- Hardware Rules (flippers, pop bumpers, slingshots, etc.)

How does the MPF SPIKE interface work?

Here's a more technical overview of how MPF talks to a Stern SPIKE machine. You don't have to read this section if you don't care.

Stern SPIKE hardware is a series of node boards that are connected via Cat-5 cables which is known as the SPIKE node bus. The CPU running the game code from the SD card on the CPU node sends commands to individual node boards to actuate drivers and set LEDs and stuff like that, and it receives switch state updates from node boards with switches attached.

When you use a Stern SPIKE machine with MPF, you install a piece of software called the "MPF SPIKE Bridge" on the SD card (ideally you first make a copy of your existing SD card and keep the original in a safe place), and then when the machine powers on, instead of running the existing game code from the SD card, the CPU runs the MPF SPIKE bridge software.

The MPF SPIKE bridge is fairly simple. Essentially all it does is relay messages from the SPIKE node bus to the debug port on the CPU node, and it also accepts commands sent via the debug port and retransmits them to the node bus.

So in order to connect a computer running MPF to the Stern SPIKE machine, you buy a small USB-to-serial adapter (Amazon.com has them for under \$10) and connect one end of it to the CPU node's debug header, and you plug the other end into your computer which is running MPF. (That can be Windows, Mac, Linux, Raspberry Pi, etc. Just a regular computer running the regular version of MPF.)

From there you just configure MPF like regular. You set the platform to "spike", you set the port that your USB-to-serial adapter is using, and you set all your coils, switches, and LEDs based on their node board & IDs from the operator's manual.

If you ever want to go back to the original game code from Stern, then just swap out the SD card with the MPF SPIKE Bridge on it and replace it with the original card from Stern and you're all set.

Stern SPIKE features that do not work (yet)!

DMD

We haven't added support for the red DMDs from SPIKE v1 machines. If you want a DMD today, you can add a standalone [RGB DMD](#) which will fit right into the position of the old DMD, or you can replace the DMD/speaker panel in your SPIKE machine with an LCD display which you can run from the HDMI output of your computer running MPF.

Sound

Currently if you want to use sound (which of course you do), the way to do it is to use the sound card in the computer running MPF and speakers connected there.

The SPIKE system has sound capabilities, and it would be nice to be able to use it along with its existing speakers and amps, but the way MPF connects via the debug port does not allow for enough bandwidth for us to do sound this way.

This is something that might change in the future, or perhaps we can find an easy way to connect the sound output from the computer to the SPIKE amp.

Servos

Once we get access to a SPIKE machine with servos, we'll get support for them added.

Stepper Motors

Once we get access to a SPIKE machine with stepper motors, we'll get support for them added.

Small LCD from WWE

WWE LEs have a small playfield LCD which is controlled via the SPIKE node bus. MPF does not yet support this, though of course you could use any HDMI display connected to the machine running MPF.

How to modify a Stern SPIKE SD card & install the MPF SPIKE bridge

1. Backup the existing SD card

When you download firmware updates from Stern's websites to a USB stick, the updates only contain the specific parts of the code that have changed since the original version.

In other words, if you break or somehow screw up the SD card with the SPIKE game code on it, you will not be able to fix it by re-downloading the latest firmware. (You'll have to call Stern and get a new SD card with the software already on it.)

So be very careful here.

Our recommendation is to create an image of the original SD card, and then put the original in a safe place and then copy the image to a new SD card. That way you're always working with a copy and the original SD card is never touched.

Note that we do not yet know which cards are best or will be fully compatible, so our recommendation is to get a card that's around the same size as the current one. Let us know what you find in terms of what works and what doesn't!

Known SD Cards that work: SanDisk Ultra Plus 16GB purchased from Best Buy

One tool you can use to backup an image of your SD Card is HDD Raw Copy. This tool will back up a copy to your local drive and you can restore it to the new SD card. For a tutorial on backing up your Stern SD card using HDD Copy check out the following video.

<https://www.youtube.com/watch?v=KlKw8raWixI&t=35s>

Note: Save a copy of your SD card image in case you need to restore your SD card. If, at one point, your SD memory card becomes corrupted, restoring from the backed up image fixes the issue.

2. Mount the SD card

You need to mount the Linux root partition (which is probably #3).

On Windows you need an additional tools to mount ext3. We got a report that "Paragon ExtFS for Windows" works fine for this.

3. Edit /etc/inittab

Last line needs to be changed to enable login without a password:

```
S0:2345:respawn:/sbin/getty 115200 ttyS0 -n -l /bin/sh
```


Furthermore, you might want to add this line to allow USB login (e.g. if your board does not have DBGU populated).

```
USB0:2345:respawn:/sbin/getty 115200 ttyUSB0 -n -l /bin/sh
```

4. Edit /etc/rc2.d/S95game

Add the following line as the new second line in this file:

```
exit 1
```

This causes this script to exit instead of running the original Stern game code. (You can remove this line again if you want to run the original game again.)

5. Install the spike bridge

Add mpf-spike-bridge to /bin/bridge and mark it as executable.

On Linux this can be done with `chmod +x bridge` from within the folder.

Get the bridge from <https://github.com/missionpinball/mpf-spike-bridge>

Note that we have a precompiled binary in there (as well as the C source code).

Note: It might be hard to mark the bridge binary as executable on Windows (but should be possible). If you cannot do this proceed to the next step and afterwards do the following:

1. Download PuTTY from www.putty.org. PuTTY is a free telnet app that allows you to remotely connect to the Linux OS running on the SPIKE system. PuTTY was also useful for verifying the connection from your Windows machine to the Linux OS running on SPIKE.
2. In PuTTY, select the “Serial” buttont, change to correct COM (COM1, COM3, COM4, etc) port and set speed to 115200 baud. If you are unsure of which COM port Windows used when you plugged in your cable, open the Device Manager in the Control Panel. Click open the PORTS drop down to find which COM port is in use.
3. Power up spike
4. Press enter and you should get a command prompt (if not, your serial connection is probably not working).
5. Type the following:

```
mount -o remount,rw /
chmod +x /bin/bridge
mount -o remount,ro /
```

6. Unmount the SD card. Put it back in your spike system

Unmount the card. Really! Do that! Spike will not boot from a corrupted filesystem. SD cards may need a while to write everything. Give them those extra 10s. This is particularly important on

Windows. If the red LED in the middle of the Stern CPU board is not blinking your SD card may be corrupt.

Note: The SD card can become corrupted when removing the card without ejecting it properly. You can fix this by restoring your backup from above.

Now when you power up the pinball machine, instead of running the original game code, it will run the spike bridge which will listen for commands from the CN2 connector and will send out information about the state of the machine via that connector.

Connecting your computer to the Stern SPIKE CPU node

There are at least 3 options to connect a computer running MPF to the SPIKE CPU via a serial connection.

1. USB to USB Null Modem Cable
2. USB to Serial Adapter
3. Using two USB to Serial Adapters

OPTION 1: USB to USB Null Modem Cable

Probably the cleanest and easiest method is to purchase the USB to USB Null Modem Cable. With this cable, you can plug one end into the USB port on your computer and the other end into one of the two USB ports on the SPIKE board. On a Windows computer, use the Device Manager to determine which COM port the cable has been assigned by Windows. Update your machine configuration with the correct COM port (example, COM5).

:

spike: port: COM5

Null modem cables used to be a common way to connect two computers together. This is the most expensive solution at about \$50 USD. However it looks just like a USB cable. The only vendor that has the USB to USB Null Modem Cable is the FDTI company.

<http://www.ftdichip.com/Products/Cables/USBtoUSB.htm>

This particular cable also provides faster data transfer rates up to 3 MBaud than Options 2 and 3.

OPTION 2: USB to Serial Adapter

The second method is to purchase a USB-to-serial adapter and connect it to the DBGU header (CN2) on the SPIKE CPU node. The problem you may have is that not all SPIKE boards have the header soldered onto the board. A header is essentially a 6 pin socket that the adapter can plug into. If you do have the header at location CN2, great! Read on.

Ok, you have a header on the SPIKE board. Simply purchase an inexpensive USB to serial adapter and plug it in. There are lots of them, most for less than \$10, and they're all pretty much the same.

Some examples that should work (though we don't guarantee it and we're happy to hear feedback or recommendations):

<https://www.amazon.com/FICBOX-CP2102-Serial-Downloader-Arduino/dp/B01CU12324/>
<https://www.amazon.com/HiLetgo-CP2102-Module-Serial-Converter/dp/B00LODGRV8>
<https://www.amazon.com/HiLetgo-Ft232rl-Serial-Adapter-Arduino/dp/B00IJXZQ7C>
<https://www.adafruit.com/products/3309> <https://www.sparkfun.com/products/12731>
<https://www.sparkfun.com/products/13830>

Make sure you have a 3.3v adapter (or that your adapter can be set for 3.3v).

Note: If you're using a Raspberry Pi, you can use its built-in serial pins and don't need a USB-to-serial adapter.

Connecting using DBGU

Connect the USB serial adapter to the DBGU header (CN2) on the SPIKE CPU node.

Pins are marked GND, RX, TX. You do not need more than these.

TODO add a photo and more detailed pinout instructions.

OPTION 3: Connect using two USB-Serial Adapters

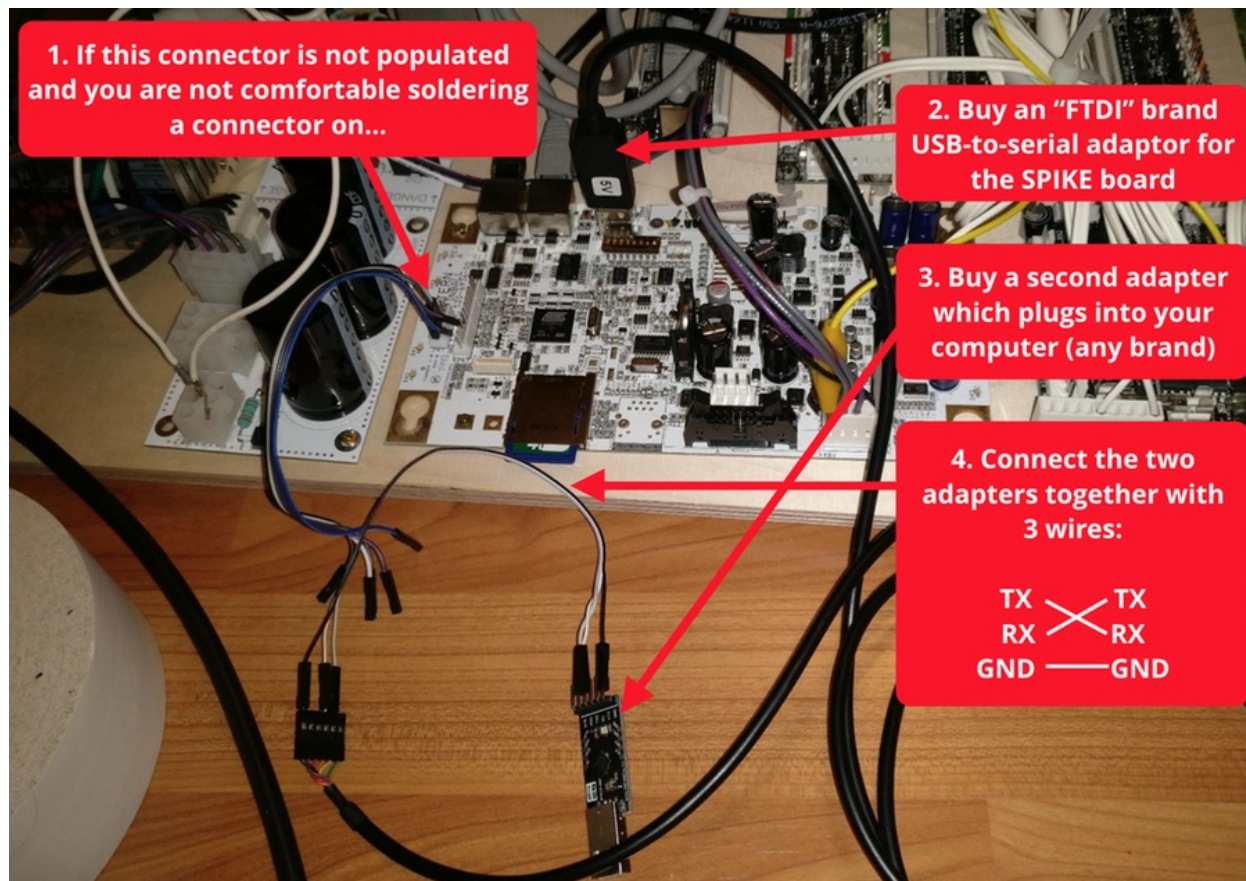
Newer versions of the SPIKE CPU node do not have a connector attached to the CN2/DBGU header. The newer board is the same, but you see a blank spot instead of the plug-in connector attached. If you do not want to solder a header onto the SPIKE board then you need to go back to Option 1 or use this option. Soldering on the SPIKE board is risky if you lack experience with a solder iron and will likely void your warranty.

For this option, you can buy two USB serial adapters and then use the USB connection on the SPIKE CPU node.

The one you connect to the SPIKE CPU node needs to have an actual FTDI brand chip because the FTDI drivers are included in the code on the SPIKE board. The second adapter for your computer can be any brand since it's easy to install whatever drivers it needs on your computer. Whatever serial port appears on your computer when you plug in this adapter is the port name you'll use in your machine config.

These two adapters will have connectors or headers on them that you need to connect together. Connect the "RX" (receive) from one to the "TX" (transmit) on the other and vice-versa. Also connect the grounds (possible labeled "GND") together. It's probably a good idea to twist the wires together to reduce interference, especially if your wires are more than a few inches long.

The following diagram illustrates how everything fits together:



You've essentially created a null modem cable as described in Option 1. This option may be a little cheaper but the solution is far less elegant and stable.

How to configure MPF for Stern SPIKE hardware

Related Config File Sections

hardware:

spike:

This guide explains how to configure MPF to work with Stern SPIKE pinball machines. It applies to SPIKE and SPIKE 2 systems.

1. Install the drivers for your USB-to-serial adapter

Before you proceed, make sure that you have the drivers properly installed for your USB-to-serial adapter and that when you plug it in, you see the serial port.

2. Configure your hardware platform for SPIKE

To use MPF with a SPIKE hardware, you need to configure your platform as spike in your machine-wide config file. You'll also need to add a "spike:" section with some additional settings:


```

hardware:
  platform: spike

spike:
  port: /dev/ttyUSB0
  baud: 115200
  debug: False
  nodes: 0, 1, 8, 9, 10, 11

```

Some notes on the settings:

port:

Use the port of your USB-serial adapter or of the internal serial on the RPi. On Windows, this will have a name like “COM5”.

baud: This needs to match the value from Step 3 in the [MPF SPIKE bridge instructions](#). Note that since only control and switch information is sent across this bus, 115k baud is plenty fast enough, though it can technically support more.

debug: Set this to true for print more details in the log.

nodes: This is a list of the node board addresses that your system has. You can get this from the manual. Here’s an example from Wrestlemania Pro:

Node Address	Description	Location	Part Number
0	SPIKE CPU Node	Backbox	520-6936-00
1	Cabinet Node	Cabinet	520-5319-00
8	Lower Playfield 48V 8-Driver Node	Lower playfield	520-6935-00
8a	Lower Playfield Serial LED Extension	Lower playfield	520-6950-00
9	Mid Playfield 48V 4-Driver Node	Mid playfield	520-5329-00
9a	Trough Serial Opto Receiver Extension	Lower playfield ball trough	520-5345-00
10	Upper Mini Playfield 4-Driver 48V Node	Upper playfield	520-5329-00
11	Mid Playfield I/O Node	Mid playfield	520-5322-00

Only map the node boards and ignore the extension boards because those are transparent to MPF. Just consider 8 and 8a/8b to be the same node.

How to configure coils & drivers (Stern SPIKE)

Related Config File Sections

spike:

coils:

To configure coils, drivers, motors, and/or magnets (basically anything connected to an node's driver outputs) for Stern SPIKE machines, you can follow the guides and instructions in the [Coils \(Solenoids\)](#) docs.

However there are a few things to know and some additional options you get with SPIKE hardware that are discussed here.

number:

The number: setting for each driver is a combination of the node it's connected to and its address from the manual. For example, here's the driver reference table from Page 11 of the Wrestlemania Pro manual:



DRIVER REFERENCE TABLE

ID	Name	Node	Con- nector	Ret. Pin	Ret. Wire	Volt- age	V+ Pin	V+ Color	Location	Type	Address	Part Number
1	Trough	8	CN8	3	ORG-GRY	48V	4	GRY-ORG	Playfield	Coil - 27-1500	8-DR-5	090-5004-ND
2	Auto Plunger	8	CN6	5	ORG-WHT	48V	6	GRY-ORG	Playfield	Coil - 23-800	8-DR-4	090-5001-ND
3	Center 3-Bank Drop Target Reset	9	CN1	3	YEL-WHT	48V	4	GRY-BLK	Playfield	Coil - 25-1240	9-DR-3	090-5034-ND
7	Ramp Control Gate Right	10	CN11	3	BLU-RED	48V	4	GRY-BRN	Back Panel	Coil - 32-1250	10-DR-3	090-5060-01-ND
8	Shaker Motor	1	CN2	1-2	RED	48V	3-5	BLU	Cabinet	Motor	1-DR-0	041-5029-04
9	Left Pop Bumper	9	CN5	3	ORG-RED	48V	4	GRY-BLK	Playfield	Coil - 26-1200	9-DR-0	090-5044-ND
10	Right Pop Bumper	9	CN7	3	ORG-BRN	48V	4	GRY-BLK	Playfield	Coil - 26-1200	9-DR-1	090-5044-ND
11	Bottom Pop Bumper	9	CN9	3	ORG-BLK	48V	4	GRY-BLK	Playfield	Coil - 26-1200	9-DR-2	090-5044-ND
12	Left Ring Slingshot	10	CN5	3	YEL-BLK	48V	4	GRY-BRN	Mini-PF	Coil - 26-1200	10-DR-0	090-5044-ND
13	Right Ring Slingshot	10	CN9	3	YEL-RED	48V	4	GRY-BRN	Mini-PF	Coil - 26-1200	10-DR-2	090-5044-ND
14	Ring Eject	10	CN7	3	YEL-BRN	48V	4	GRY-BRN	Mini-PF	Coil - 27-1500	10-DR-1	090-5004-ND
15	Left Flipper	8	CN5	3	ORG-YEL	48V	4	GRY-ORG	Playfield	Coil - 24-850	8-DR-0	090-5083-03-ND
16	Right Flipper	8	CN7	3	ORG-GRN	48V	4	GRY-ORG	Playfield	Coil - 24-850	8-DR-1	090-5083-03-ND
17	Left Slingshot	8	CN12	5	ORG-BLU	48V	6	GRY-ORG	Playfield	Coil - 26-1200	8-DR-7	090-5044-ND
18	Right Slingshot	8	CN10	5	ORG-VIO	48V	6	GRY-ORG	Playfield	Coil - 26-1200	8-DR-6	090-5044-ND
20	Left Flipper Hold	8	CN9	3	YEL-ORG	48V	4	GRY-ORG	Playfield	Coil - 31-3500	8-DR-2	090-5083-03-ND
21	Right Flipper Hold	8	CN11	3	YEL-GRN	48V	4	GRY-ORG	Playfield	Coil - 31-3500	8-DR-3	090-5083-03-ND
30	Meter 1	1	CN3	2	BLK	12V	1	RED	Cabinet	Digital Out	1-DR-2	500-9946-00
31	Meter 2	1	CN4	2	BLK	12V	1	RED	Cabinet	Digital Out	1-DR-3	500-9946-00
32	Ticket Dispenser	1	CN11	3		12V	1		Cabinet	Digital Out	1-DR-4	

The address for each driver is in the highlighted column. To enter the number for the driver into MPF, remove the middle "DR" letters so you just have the node number and address number (with a dash between them). For example, the driver for the left flipper coil with the address 8-DR-0 would be entered into the MPF config as 8-0, etc.

```
coils:
  c_shaker:
    number: 1-10 # Node 1, coil 10
    pulse_ms: 100
    allow_enable: true
```



```
c_flipper:
    number: 8-1 # Node 8, coil 1
```

How to configure LEDs & GI (Stern SPIKE)

Related Config File Sections
<i>matrix_lights:</i>
<i>leds:</i>
<i>spike:</i>

Stern SPIKE machines have replaced all incandescent lights with LEDs. Instead of a lamp matrix, individual LEDs are connected to node boards and can be controlled with 256 levels of brightness.

GI (general illumination) are regular LEDs, and so are flashers, and so are the white backlight LEDs in the backbox. So pretty much everything is an LED.

Many LEDs are single element, single color, with colored inserters in front of them. This means that you cannot control the color of the LED, rather, you just control the brightness and the color is what it is.

Most machines also have RGB LEDs that can be set to any color. In those cases the individual red, green, and blue channels each have their own addresses, and then you can group them together into a single, logical RGB LED that you can set to whatever color you want.

Finally, in SPIKE machines, you'll sometimes see several LEDs connected to a single output, meaning that when you set the brightness of that output, you're setting the brightness for all those LEDs.

MPF uses the `matrix_lights:` section of the machine config to define LEDs. (This is somewhat confusing because LEDs in a SPIKE system are certainly *not* matrix lights, but the LED system in MPF currently assumes that all LEDs are RGB LEDs, and that's not how Stern SPIKE systems work. So you configure your LEDs as matrix lights. (This will be fixed in a feature version of MPF.)

Most of the settings in the [Lights](#) documentation apply to LEDs in Stern SPIKE machines, though there are a few SPIKE-specific things to know.

number:

The main thing you need to know about configuring LEDs (besides the fact that you add them to the `matrix_lights:` section of your config) is how the hardware numbering works.

Pretty much you just look up the number in the manual for your machine and then enter it without any letters. For example, here is (part of) the lighting chart from *Wrestlemania Pro*:

3.2 LIGHTING REFERENCE

ID	Name	Node	Node Ext.	Conn.	Ret. Pin	Ret. Wire	Src. Pin	Src. Wire	Location	Type	Light Color	Address	Part Number
1	Start Button	1	-	CN6	3	YEL-BRN	1	REDv	Cabinet	Feature	White	1-LP-2	112-5033-08
2	Tournament Start Button	1	-	CN6	4	YEL-RED	1	RED	Cabinet	Feature	White	1-LP-3	112-5033-08
3	Shoot Again	8	8a	8a-CN1	3	RED-GRY	5	RED	Playfield	Feature	White	8a-LP-47	520-5307-00
4	100 Thousand	8	8a	8a-CN1	2	GRN-GRY	5	RED	Playfield	Feature	White	8a-LP-46	520-5307-00
5	200 Thousand	8	8a	8a-CN1	1	BLU-GRY	5	RED	Playfield	Feature	White	8a-LP-45	520-5307-00
6	300 Thousand	8	8a	CN14	D7	-	-	-	Playfield	Feature	White	8a-LP-20	520-6950-00
7	400 Thousand	8	8a	CN14	D6	-	-	-	Playfield	Feature	White	8a-LP-19	520-6950-00
8	500 Thousand	8	8a	CN14	D5	-	-	-	Playfield	Feature	White	8a-LP-18	520-6950-00
9	600 Thousand	8	8a	CN14	D4	-	-	-	Playfield	Feature	White	8a-LP-17	520-6950-00
10	700 Thousand	8	8a	CN14	D18	-	-	-	Playfield	Feature	White	8a-LP-30	520-6950-00
11	800 Thousand	8	8a	CN14	D17	-	-	-	Playfield	Feature	White	8a-LP-29	520-6950-00
12	900 Thousand	8	8a	CN14	D12	-	-	-	Playfield	Feature	White	8a-LP-25	520-6950-00
13	1 Million	8	8a	CN14	D3	-	-	-	Playfield	Feature	White	8a-LP-16	520-6950-00
14	2 Million	8	8a	CN14	D11	-	-	-	Playfield	Feature	White	8a-LP-24	520-6950-00
15	3 Million	8	8a	CN14	D16	-	-	-	Playfield	Feature	White	8a-LP-28	520-6950-00
16	4 Million	8	8a	CN14	D10	-	-	-	Playfield	Feature	White	8a-LP-23	520-6950-00

Use the address column (highlighted in yellow) to get the numbers for each LED. Remove the “LP” letters, and also remove any lowercase letters (like the “a”) from the node. What you’re left with is the node address and LED number.

For example, the Shoot Again light with the address 8a-LP-47 would be entered as number: 8-47.

```
matrix_lights:
  backlight:
    number: 0-0 # 0-0 is the special address for the backlight
  start_button:
    number: 1-2
  tourney_start_button:
    number: 1-3
  shoot_again:
    number: 8-47
```

The backbox backlight Stern SPIKE systems have controllable brightness for the white lights in the backbox that illuminate the translight. All of those LEDs are tied together and controlled as one with the address 0-0.

GI (General Illumination) GI in Stern SPIKE systems are just regular LEDs. You can tag them with the tag gi and then turn them on in the attract mode and/or use them in shows for special effects. Really there’s nothing special about them. They’re just lights. (Just remember they’re controlled and defined as “lights”, not as “GIs”.)

Flashers Flashers in Stern SPIKE systems are also controlled just like normal lights. They just happen to be super bright, but other than that, use them like any other LED. (Just remember they’re controlled and defined as “lights”, not as “flashers”.)

RGB LEDs

You’ll notice in the operator’s manual that RGB LEDs are actually three separate LEDs with a separate address for the red, green, and blue channel. Since MPF deals with RGB LEDs as single objects you can set to any color, you need to group the three individual channels of RGB LEDs into single RGB objects.

Here’s an example from the Wrestlemania Pro manual:

29	Left Lane Arrow(Red)	11	-	CN2	7	RED-VIO	2	RED	Playfield	Feature	RGB	11-LP-3	520-5333-00
30	Left Lane Arrow(Green)	11	-	CN2	8	GRN-VIO	2	RED	Playfield	Feature	RGB	11-LP-4	520-5333-00
31	Left Lane Arrow(Blue)	11	-	CN2	9	BLU-VIO	2	RED	Playfield	Feature	RGB	11-LP-5	520-5333-00

You'd enter the three channels as three separate lights in the `matrix_lights:` section of your machine config.

Once you do that, add a `leds:` section to your config, and then create an entry for the RGB LED name you'd like to use to control refer to the RGB LED which you can then set to any color. Then under there, for the `number:`, enter the three names from the `matrix_lights:` section (in order red, green, blue), and add the entry `platform: lights`.

What this does is create a new virtual RGB LED which is a grouping of the three LED channels into the RGB LED. Then you can use it like any LED.

Note that when you do this, you will control the RGB LEDs as “leds” in your configs, while you'll control the single color LEDs, the GI, and the backbox light as “lights”. Is that weird? Yes. But it works.

```
matrix_lights:
  left_lane_arrow_red:
    number: 11-3
  left_lane_arrow_green:
    number: 11-4
  left_lane_arrow_blue:
    number: 11-5

leds:
  left_lane_arrow:
    number: left_lane_arrow_red, left_lane_arrow_green, left_lane_arrow_blue
    platform: lights
```

How to configure switches (Stern SPIKE)

Related Config File Sections

[*spike:*](#)

[*switches:*](#)

To configure switches on Stern SPIKE machines, you can follow the guides and instructions in the [*Switches*](#) docs.

The only special thing to know is how the number works.

number:

The number of a switch on a Stern SPIKE machine is a combination of the address of the node its plugged into, and then its individual ID.

You can find the switch numbers are in the manual. Omit the “SW” and letters for extension boards. Here's an example from Wrestlemania Pro:

3.3 SWITCH REFERENCE

ID	Name	Node	Node Ext	Conn.	Input Pin	Input Wire	GND Pin	Ground Wire	Location	Type	Address	Part Number
1	Left Return Lane	11	-	CN7	2	LGN-YEL	10	BLK-RED	Playfield	Rollover	11-SW-0	500-9935-04
2	Right Return Lane	11	-	CN5	12	PNK-BLK	10	BLK-GRY	Playfield	Rollover	11-SW-8	500-9935-04
3	Left Outlane	11	-	CN7	3	LGN-BLU	10	BLK-RED	Playfield	Rollover	11-SW-1	500-9935-04
4	Right Outlane	11	-	CN5	3	PNK-BRN	10	BLK-GRY	Playfield	Rollover	11-SW-9	500-9935-04
5	Left Slingshot	8	-	CN12	4	GRY-BLU	3	BLK-GRN	Playfield	Leaf	8-SW-7	180-5231-00
6	Right Slingshot	8	-	CN10	4	GRY-VIO	3	BLK-GRN	Playfield	Leaf	8-SW-6	180-5231-00
7	Center 3-Bank Drop Target Right	9	-	CN15	4	WHT-ORG	14	BLK-BLU	Playfield	Opto	9-SW-6	520-5252-13
8	Center 3-Bank Drop Target Center	9	-	CN15	3	WHT-RED	14	BLK-BLU	Playfield	Opto	9-SW-5	520-5252-13
9	Center 3-Bank Drop Target Left	9	-	CN15	2	WHT-BRN	14	BLK-BLU	Playfield	Opto	9-SW-4	520-5252-13
10	Left Flipper Button	8	-	CN9	2	GRY-BRN	1	BLK-GRN	Cabinet	Leaf	8-SW-2	180-5164-01
11	Right Flipper Button	8	-	CN11	2	GRY-RED	1	BLK-GRN	Cabinet	Leaf	8-SW-3	180-5164-01
12	Left Lane	11	-	CN7	5	LGN-GRY	10	BLK-RED	Playfield	Rollover	11-SW-3	500-9935-04
14	Left Orbit	9	-	CN15	9	WHT-GRY	14	BLK-BLU	Playfield	Rollover	9-SW-11	180-5230-01
15	Tournament Start Button	1	-	CN6	9	GRY-WHT	5	BLK-WHT	Cabinet	Micro	1-SW-12	180-5174-00
16	Trough 6	9	9a	CN14	-	-	-	-	Playfield	Opto	9a-SW-17	520-5344-00 tx 520-5345-00 rx
17	Trough 5	9	9a	CN14	-	-	-	-	Playfield	Opto	9a-SW-18	520-5344-00 tx 520-5345-00 rx

This would result in the following switch entries:

switches:

```

s_left_inlane:
  number: 11-0
s_right_inlane:
  number: 11-8
s_left_outlane:
  number: 11-1
s_right_outlane:
  number: 11-9
s_left_sling:
  number: 8-7
s_right_sling:
  number: 8-6
s_center_drops_right:
  number: 9-6
  type: NO
s_center_drops_middle:
  number: 9-5
  type: NO
s_center_drops_left:
  number: 9-4
  type: NO
s_left_flipper:
  number: 8-2
s_right_flipper:
  number: 8-3
s_left_lane:
  number: 11-3
s_left_orbit:
  number: 9-11
s_tourney_start:
  number: 1-12

```



```
s_trough_6:
  number: 9-17
  type: NO
s_trough_5:
  number: 9-18
  type: NO
```

Note that optos (highlighted in green) need to have the type: NO added to them.

How to use MPF with Gottlieb System 1 or 80 machines

New in version 0.50.

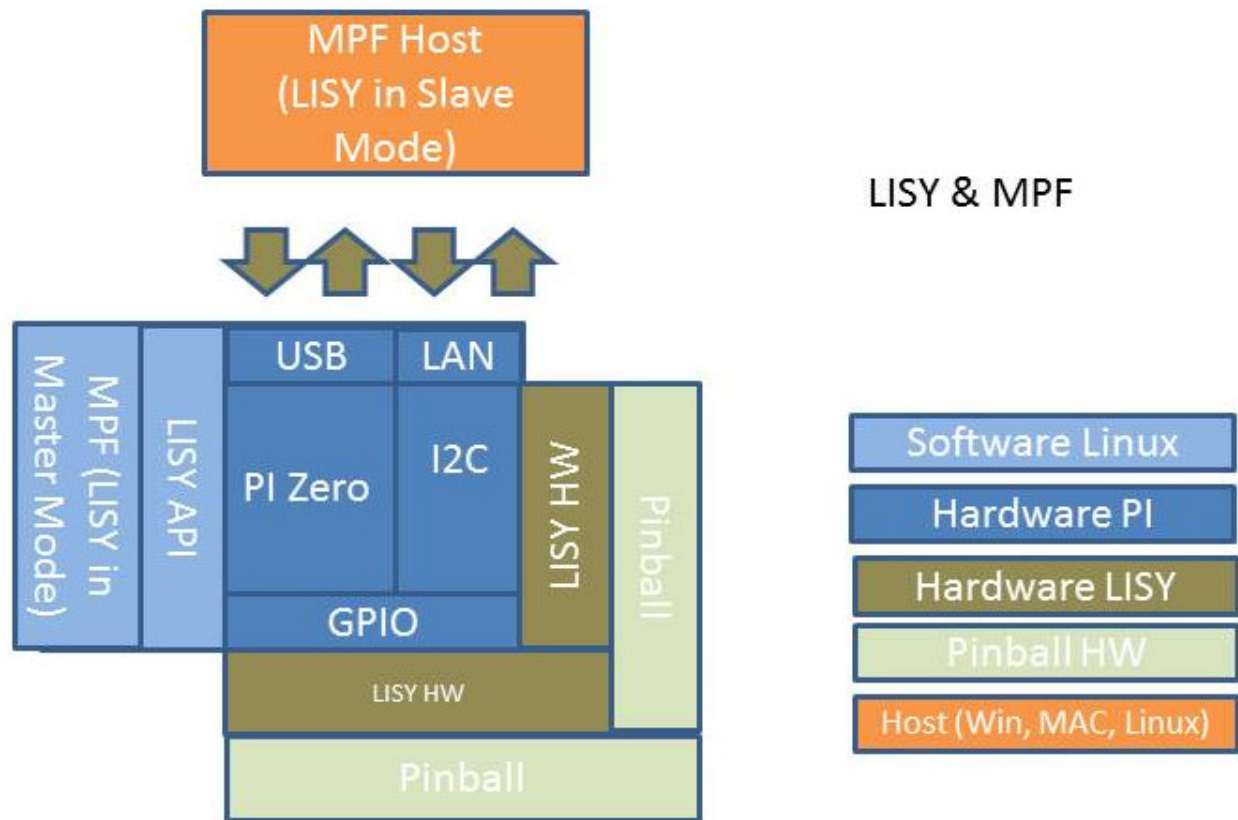
MPF can directly control Gottlieb System 1 or System 80 machines via the LISY1 or LISY80 controller boards (with firmware 4.02+).

Note: For general installation instruction and some background information on the LISY hardware platform, visit www.lisy80.com.

There are two ways this can be done:

1. Run MPF on a standalone PC which connects to the LISY hardware operating in “slave” mode via Ethernet, WiFi, or serial. This is generally recommended during development since it’s easier to work on your MPF config using your own computer. You can also use this configuration if you want to add an LCD or DMD to the older Gottlieb machine.
2. Run MPF on the LISY hardware directly (“master” mode). (Technically MPF is running on the LISY controller’s Raspberry Pi Zero.) This option is nice when your game is finished and you no longer want to connect a PC. Note that the Raspberry Pi on the LISY is not powerful enough to run the MPF media controller, so this option is really only valid for simpler, segment display type games. If you want to run a full LCD or DMD, then just run MPF on a separate computer (which can still be small and inside your machine) and connect to the LISY controller via Option (a) above.

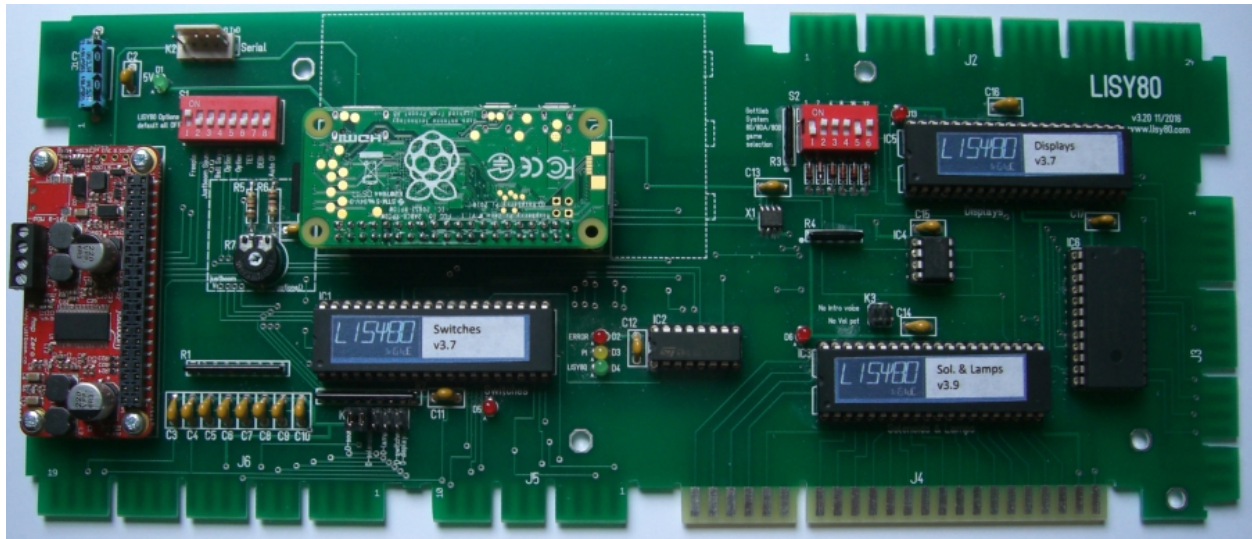
See the following image for an architecture overview:



1. Replace your original MPU with LISY1/80.

For Gottlieb System80/80A/80B games, replace the existing Gottlieb CPU with the “LISY80” board. For System 1 machines, replace the existing Gottlieb CPU board with the “LISY1” board. (Note that the people who created the LISY boards are also working on a “LIST35” board for old Bally machines with AS-2518-17 or AS-2518-35 CPU boards).

Note: See documentation at www.lisy80.com for details. Basically you replace the MPU with the LISY board. You can still play the original ROM using PinMAME on LISY.



2. Configure LISY DIP switches

If you want to run MPF on the LISY controller itself, set DIP 4 (option1) and DIP 8 (autostart) to 'ON' and all other DIPs on that switch to 'OFF'. This will configure the LISY board to boot to MPF instead of the default PinMAME.

If you want to use the LISY board in "slave" mode where you run MPF on a separate computer and remotely control the LISY board, set DIP 6 to 'ON'. Then to control the mode that the LISY board will communicate with the host PC running MPF, set DIP 2 to 'ON' for network mode or 'OFF' for serial mode.

Switch S1								Mode
S1	S2	S3	S4	S5	S6	S7	S8	
off	off	off	on	off	off	off	on	MPF Master Mode
off	off	off	on	off	on	off	on	MPF Slave Mode (Serial)
off	on	off	on	off	on	off	on	MPF Slave Mode (Network)

As usual, configure your specific Game Hardware via Switch 'S2'. For instance, for *Devils Dare*, which is internal number '18', set S2 DIP 2 and DIP 5 to 'ON' and all others to 'OFF' (binary coding of decimal 18).

3a. Add MPF config to SD Card (only needed for MPF Master Mode)

If you're using the "master" mode where MPF runs on the LISY board itself, you need to get your MPF config installed onto the LISY board. You can do this via the SD card.

Place your MPF config in the folder `/boot/mpfcfg/xxx/` on the SD Card (replace "xxx" with your game number with leading zeros if it's shorter than three digits). For instance with *Dare Devil*, the game would be at `/boot/mpfcfg/018/` on the SD card.

It's easiest to do this with an SD card reader on your computer, though you could also copy the files using SSH connected to a running LISY controller (see www.lisy80.com for details).

Again, we only recommend this option for your “final” config, as it’s much easier to use the LISY board in slave mode and run MPF off your computer while you’re developing your game.

Warning: This mode of operation will not allow you to run the MPF-MC since the LISY’s Raspberry Pi Zero is not powerful enough. If you want to add an LCD or DMD to your machine, use the slave option detailed below.

3b. Connect your PC running MPF to LISY via network or serial (only needed for MPF Slave Mode)

If you’re using the “slave” mode where you run MPF on a standalone computer and then connect to the LISY board via the network or serial, once you configure the LISY board’s DIP switches from Step 2 then you need to update your machine config file for MPF running on your computer to be able to connect to the LISY board.

If you want to use the serial port, add/update the following sections in your machine config:

```
hardware:
  platform: lisy

lisy:
  connection: serial
  port: com1          # replace this with your com port
  baud: 115200
```

Alternatively, if you want to connect using WiFi or Ethernet, add/update the following sections in your machine config:

```
hardware:
  platform: lisy

lisy:
  connection: network
  network_port: 5963
  network_host: a.b.c.d  # replace this with the IP of LISY
```

4. Power up LISY

Power up your system and enjoy.

4a. Start MPF (only needed for MPF Slave Mode)

Start MPF on you PC. Optionally start MPF-MC (if you want to use an additional DMD or LCD).

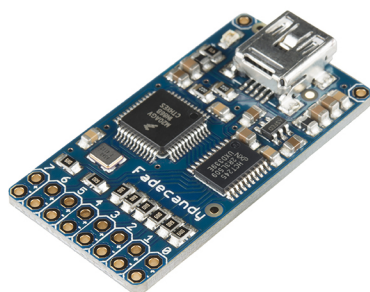
Snux System 11 Driver Board

TODO

How to configure a FadeCandy RGB LED Controller

Related Config File Sections
<i>hardware:</i>
<i>leds:</i>
<i>fadecandy:</i>
<i>open_pixel_control:</i>

MPF allows you to use a FadeCandy LED controller to drive the LEDs in your pinball machine. A FadeCandy is a small, cheap (\$25) USB controller which can drive up to 512 serially-controlled RGB LEDs.



You can use the FadeCandy in place of connecting your LEDs to a P-ROC/P3-ROC controller, or you can choose to drive some LEDs via your primary pinball controller and some via the FadeCandy. (This is useful if you want to use more LEDs than what your controller platform supports.)

You can connect up to four FadeCandy boards to drive a total of 2048 LEDs (Which would be insane. And awesome.)

You can read more about the FadeCandy on the main page of the [FadeCandy software repository](#) in GitHub or on [Adafruit](#) or [SparkFun](#), where you can buy one for \$25. The FadeCandy is very advanced, offering advanced light processing capabilities such as dithering and interpolation that are not available if you just control LEDs directly.

If you're not familiar with the FadeCandy, check out this intro video from SparkFun:

<https://www.youtube.com/watch?v=-4AUBjV7Y-w>

1. Understanding all the parts and pieces

Before we dig in to setting up a FadeCandy with MPF, let's look at how all the various components will fit together:

- The FadeCandy is a piece of hardware that talks to your host computer via USB. (So if you use it in a pinball machine then you'll have two devices connected via USB—your pinball controller and your FadeCandy.)
- The FadeCandy hardware is driven a FadeCandy server software that you'll run on your host computer along side the MPF game engine and the MPF media controller. The FadeCandy server talks to the FadeCandy hardware via a USB driver.

- The FadeCandy server receives instructions for LEDs connected to the FadeCandy via a protocol called [Open Pixel Control](#) (OPC).

Putting it all together, MPF talks to the FadeCandy server via OPC, and the FadeCandy server talks to the FadeCandy hardware via USB.

2. Download the FadeCandy package from GitHub

The first step is to download the [FadeCandy package](#) from GitHub. You can unzip it to wherever you want.

3. Install the FadeCandy drivers

When I (Brian) plugged the FadeCandy hardware into my Windows computer, the driver did not install automatically. Running the fcserver (next step) said it was installing the drivers, but that didn't do anything for me. (It just said "this may take awhile" but I killed it when it didn't seem like it was actually doing anything.)

In my case, I googled and found [this procedure](#) to build custom .inf files for Windows. It seems crazy but it wasn't too bad. I had to build two: One for the FadeCandy device and one for the FadeCandy boot loader. Either way, you can follow the docs and the forums around the FadeCandy and get it setup.

4. Setup the fcserver

The FadeCandy download package includes pre-built binaries for Mac and Windows. On Linux you can compile it. Again, the FadeCandy documentation has details about how to do this.

At this point you should be able to run the fcserver and to talk to your FadeCandy LEDs and get them to do things. There are a bunch of sample apps in the FadeCandy package that are kind of cool.

5. Set your LEDs to use the "fadecandy" platform

Next you need to configure your LEDs in MPF to use the fadecandy platform. By default, all types of devices are assumed to be using the same platform that you have set in the [hardware:](#) of your machine config file. So if your platform is set to fast, MPF assumes your LEDs are connected to a FAST controller; and if your platform is set to p_roc or p3_roc, MPF assumes your LEDs are connected to a PD-LED board.

To configure MPF to use FadeCandy LEDs, you can add an entry to the hardware: section of your machine config to tell it to override the default platform for your LEDs and to instead use the fadecandy platform, like this:

```
hardware:
  platform: p_roc
  driverboards: pdb
  leds: fadecandy
```

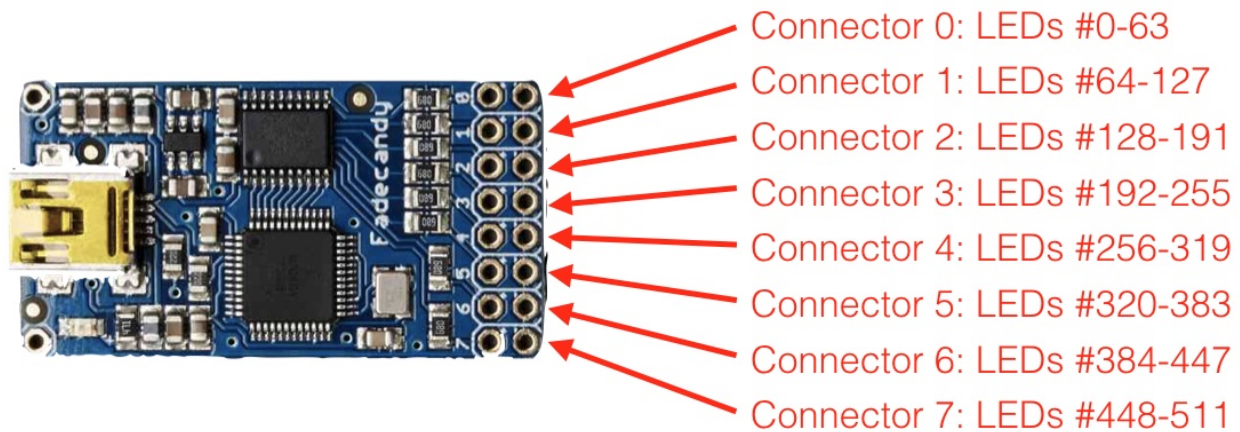
See the [Mixing-and-Matching hardware platforms](#) guide for more information about setting device-specific default platforms versus overriding the platform for individual devices.

6. Understanding FadeCandy LED numbering

The FadeCandy hardware has 8 connectors for LEDs, each of which can support up to 64 RGB LEDs (for 512 RGB LEDs total). The connectors are numbered 0-7.

The individual LED numbers are sequential across channels. The first LED on Connector 0 is #0, the second is #1, etc., up #63 on Connector 0. Then Connector 1 picks up where Connector 0 leaves off, with the first LED on Connector 2 being #64, and so on. The FadeCandy doesn't actually know how many LEDs are connected to each connector, so the first LED on Connector 1 is always LED #64 even if you have less than 64 LEDs physically connected to Connector 0.

The following diagram explains how the numbering works:



Consider the following config:

```
leds:
  l_led0:
    number: 0 # first LED on connector 0
  l_led1:
    number: 1 # second LED on connector 0
  l_led2:
    number: 128 # first LED on connector 2
```

6a. Numbering with more than one FadeCandy board

If you have more than one FadeCandy board, you can specify the board number (starting with 0) along with the LED number, like this:

```
leds:
  l_led0:
    number: 0 # first LED on connector 0 of the first board
  l_led1:
    number: 0-1 # second LED on connector 0 of the first board
  l_led2:
    number: 1-128 # first LED on connector 2 of the second board
```

(If you only have one FadeCandy board, MPF automatically adds the 0- to the number, so you don't have to specify the board number if you only have one board.)

Since MPF can support up to four FadeCandy boards, valid board numbers are 0-3.

(If you're familiar with the Open Pixel Control protocol, all of the LEDs on a single FadeCandy board are on the same OPC channel, which is technically what you're specifying with the number before the dash.)

If you do add more than one FadeCandy board, see the FadeCandy documentation for instructions on how to configure the additional FadeCandy boards for the addresses with higher than 0.

7. Launch the fcserver

In order for MPF to communicate with the FadeCandy, the fcserver has to be running. Refer to the FadeCandy documentation for instructions for this. On Windows, for example, it's just called `fcserver.exe`.

There are several command line options you can use with the server, though you don't need any of them with MPF unless you have more than one FadeCandy board connected.

You should launch fcserver in its own window since it will take over the console when it's running. It's also safe to keep it running all the time, or you can add it to a batch file to run it automatically. On my system, the fcserver puts some error message on the screen about not being able to connect to something, but everything still works even with that message continually being written to the console. (I think it's something to do with the P-ROC's FTDI driver? It only comes up when the P-ROC is on.)

8. Additional FadeCandy LED options

The FadeCandy hardware supports some advanced options which are configured in the *fadecandy* section of your machine configuration file. Specifically, you can set the keyframe interpolation, dithering, gamma, white point, linear slope, and linear cutoff. The defaults should be fine for almost everyone, though you can go nuts if you want.

I2C Servo Controllers

MPF currently supports PCA9685/PCA9635 based servo controllers via I2C. One example for such a controller is the [Adafruit 16-Channel 12-bit PWM/Servo Driver](#). We currently only support I2C on the P3-Roc but it would be easy to support on other devices such as the Raspberry PI. Let us know if you need that.

1. Installing I2C Servo Controllers

Connect the controller to the I2C port and add the following config section:

```
hardware:
  servo_controllers: pololu_maestro
  [...]

servo_controller:
  address: 0x40
```

0x40 is actually the default I2C address for this chip but it might be different for some chips.

2. Add your servos

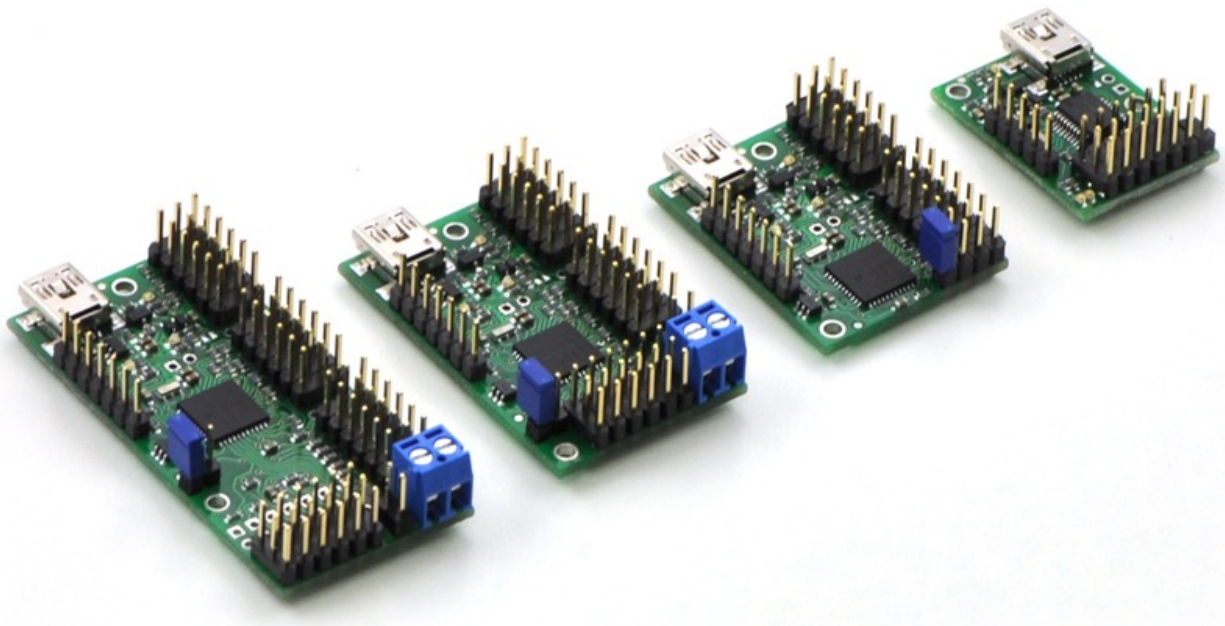
Add your servos to config:

```
servos:  
  servo1:  
    number: 0
```

All these config options are explained in-depth in the [servos: section](#) of the config file reference.

Pololu Maestro Servo Controller

MPF supports servos connected to Pololu Maestro servo controllers. Each Maestro can control multiple servos, with models that control 6, 12, 18, or 24 servos.



1. Install the Pololu Maestro drivers

Just like any hardware device you connect to a computer, you need to install the drivers so your computer can see it. It is easier to do the initial hardware configuration on a Windows PC. Follow the “Getting Started” section of the [Pololu Maestro Servo Controller User’s Guide](#). You will need to set Maestro’s serial mode to USB Dual Port on the Serial Settings tab of the Maestro Control Center.

2. Configure your hardware platform section

Next, you need to tell MPF that you want to use the `pololu_maestro` platform for servos. (MPF supports several different models of servo controllers.)

To do this, add `servo_controllers: pololu_maestro` to the `hardware:` section of your machine-wide config file, like this:


```
hardware:
  platform: fast
  driverboards: fast
  servo_controllers: pololu_maestro
```

This tells MPF that you want the default servo platform to be `pololu_maestro`. If you happen to be using multiple different types of servo controllers, you can override the default by adding a `platform:` entry to individual servo devices (just like any device in MPF that can have its platform overwritten in the device config).

3. Configure the serial port

Next, you need to tell MPF what port the Maestro is connected to. (Note that when you plug in the Maestro, you'll see two serial ports appear. You want to use the first one (the lower number).

Add a section to your machine-wide config like this:

```
pololu_maestro:
  port: COM5
```

On Linux or Mac, it will probably look like this:

```
pololu_maestro:
  port: /dev/ttyACM0
```

4. Add your servo devices

Now that all your hardware is configured, you can add the actual servos to your machine config. In MPF, servos are just like any other device (light, LEDs, coils, etc.) You add a `servos:` section to your config, and then create sub entries in there for each servo you have.

For example:

```
servos:
  servo1:
    servo_min: 0.2
    servo_max: 0.8
    positions:
      0.1: servo1_down
      0.9: servo1_up
    reset_position: 0.5
    reset_events: reset_servo1
    number: 1
  servo2:
    positions:
      0.2: servo2_left
      1.0: servo2_home
    reset_position: 1.0
    reset_events: reset_servo2
    number: 2
```

Okay, there's a lot going on in there. Let's break it down.

First, all these config options are explained in-depth in the [servos: section](#) of the config file reference. But let's point out a few Maestro-specific things here.

The `number:` of the servo is simply which channel on the Maestro board each servo is connected to. These numbers start with 0, so a Micro Maestro 6 supports six servos via numbers 0-5, the Mini Maestro 12 supports twelve servos numbered 0-11, etc.

All servo positioning in MPF is controlled via a floating point value from 0.0 to 1.0. In other words, if you tell a servo to go to position 0.0, that will be one end of its motion, and position 1.0 will be the other end. A value of 0.4 will tell the servo to move to a position that's 40% along from the start limit to the stop limit, etc.

So that's universal, 0.0 - 1.0, throughout MPF.

The way servos actually move to a position is that the servo controller sends a series of microsecond-level pulses which the servo reads and can then translate into a certain position. The actual value of these pulses varies depending on the servo controller and servos you actually have.

You may also set `servo_min` and `servo_max` if the servo is trying to move beyond its (hardware) limits when setting it to position 0.0 or 1.0. Those two values will be applied to all positions. For instance, if you move it to 0.0 it will actually move to `servo_min` (0.2 in the example) and to `servo_max` for 1.0 (0.8 in the example). Everything in between will be interpolated.

5. Using the servo in your game

The `servo's position:` setting contains a list of numerical servo values mapped to MPF events. So to move a servo in your game, just add the position you want to the list and then post that event.

Again, see the [servos: section](#) of the config file reference for details.

6. Future enhancements

The Pololu Maestro servo controllers can accept speed and acceleration settings which specify how fast the servo moves to the new position, and how (or whether) it accelerates and decelerates when starting and stopping.

These settings have not been implemented in MPF. (They're not hard, we just haven't done it.) So if you need them, contact us and we'll add them.)

Also the multiple Pololu Maestro controllers can be chained together (via a single USB port). We also don't have support for that. (It requires adding and additional address setting to the servo config.) Again if you want that, let us know and we'll add it.

How to configure a "SmartMatrix" RGB LED DMD

Related Config File Sections
hardware:
physical_rgb_dmds:
smartmatrix:

This guide explains how to connect a SmartMatrix RGB LED DMD to a pinball machine running MPF.

A **SmartMatrix** is a cheap (\$15) board that you attach to a Teensy (\$20) microcontroller which lets you connect an RGB DMD matrix display to the computer running MPF. It's a standalone solution which you can use to add an RGB DMD to a pinball machine that's using FAST Pinball, P-ROC/P3-ROC, or OPP controller hardware.

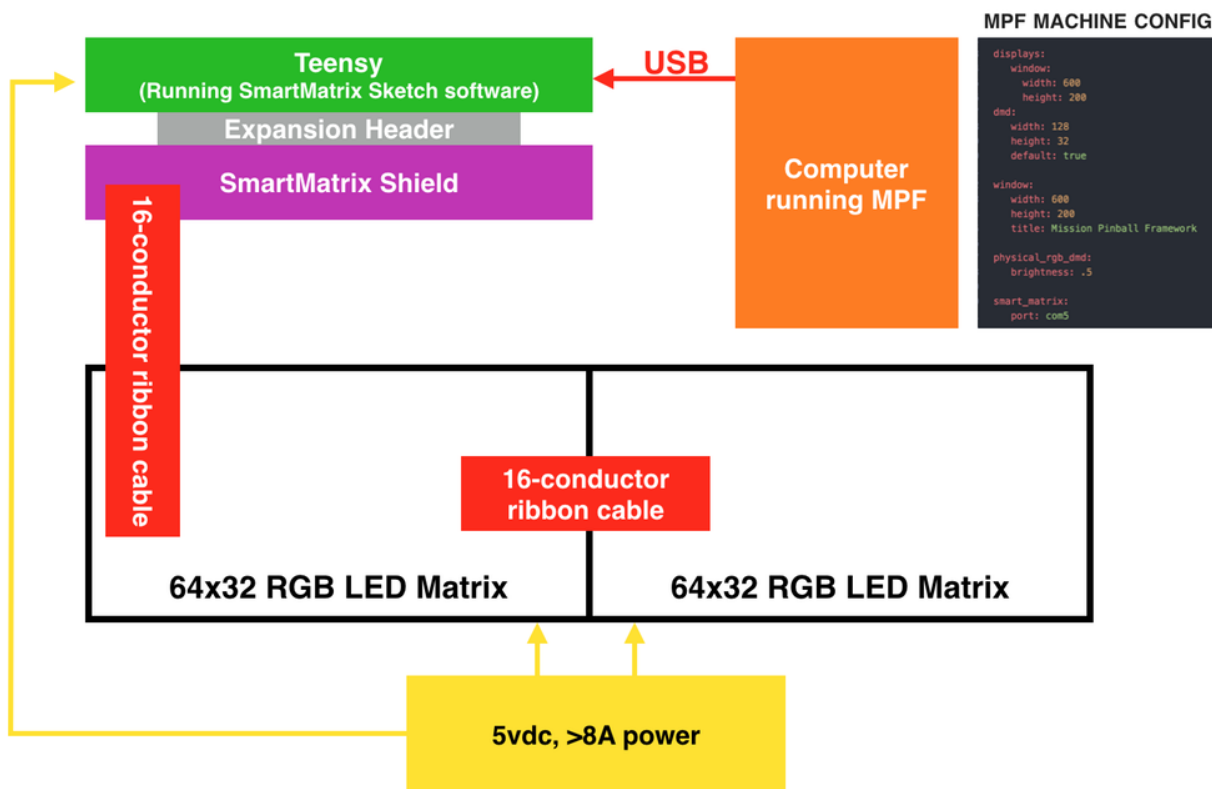
MPF supports several different types of RGB DMDs, and the SmartMatrix is just one of the options. More information about this type of display and other options that MPF supports is available in the [Using an RGB full-color LED DMD](#) documentation.

Here's an image of the SmartMatrix RGB DMD in action:



And a video which explains it all: <https://www.youtube.com/watch?v=zbZQCBYeXOU>

The following diagram shows how all the components fit together:



1. Buy all the parts you need

This solution is very much a “home brew” solution that will require you to buy a lot of parts from various sources.

Alternatively, FAST pinball also offers a RGB DMD which contains controller, panels and mounting brackets (ask them directly since it is not currently listed on their website). If you go with this solution skip steps 1 to 3. You still need a power supply (step 4).

(1) The Panels

We originally had to buy the panels directly from China via AliExpress, but now FAST Pinball sells a kit. The FAST Pinball option is nice because the price is great and they also include a mounting bracket that fits a standard DMD cutout (ask them directly since it is not currently listed on their website).

If you buy the panels yourself on AliExpress, you’ll pay about the same price for just the panels, you won’t have a mounting bracket, and you’ll have to deal with customer support from China. Also FAST tests the panels to make sure all the pixels work—a problem people were running into when buying from AliExpress.

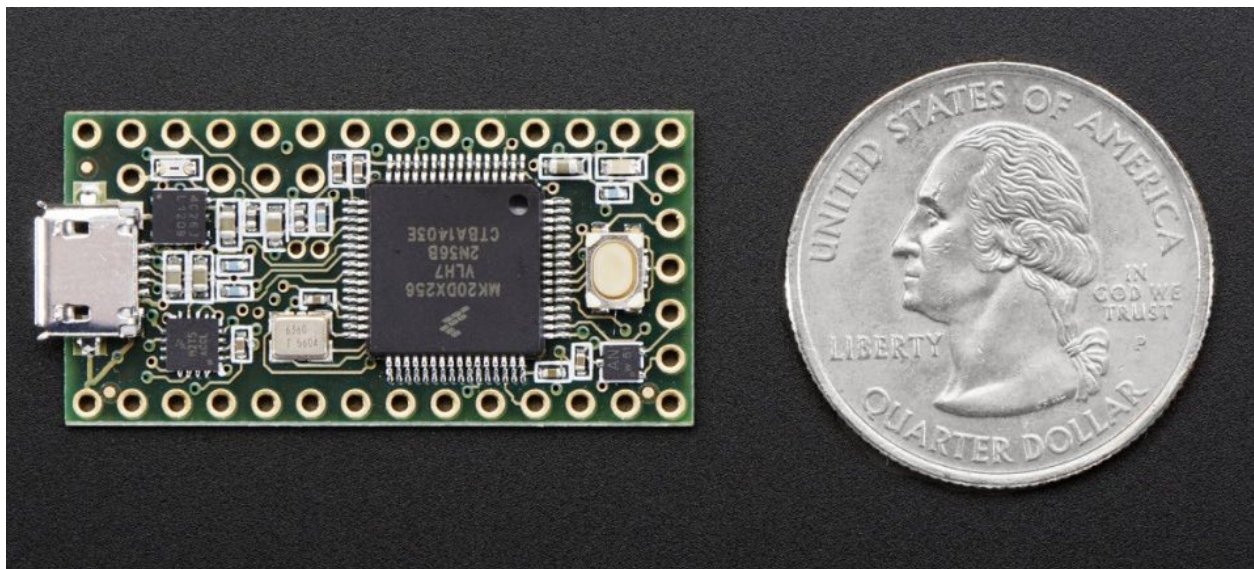
(2) The Teensy

Once you have your panel, you need a way to talk to them via a computer. The panels use some kind of 16-pin signalling system which is some kind of standard in the gigantic advertising display industry.

The solution for MPF is to use a Teensy 3.2 (which is kind of like an Arduino). The Teensy is available from multiple sources for about \$20. [Here’s the link to the website](#) of the guy who actually built it, and you can also [get it from Adafruit](#) which is nice because you also need the shield (from the next step) which is also available from them.

The Teensy runs the same software sketches as Arduinos, though it has a slightly different processor architecture which is needed for the rapid bit-shifting of data needed to control these panels.

Here’s a Teensy:

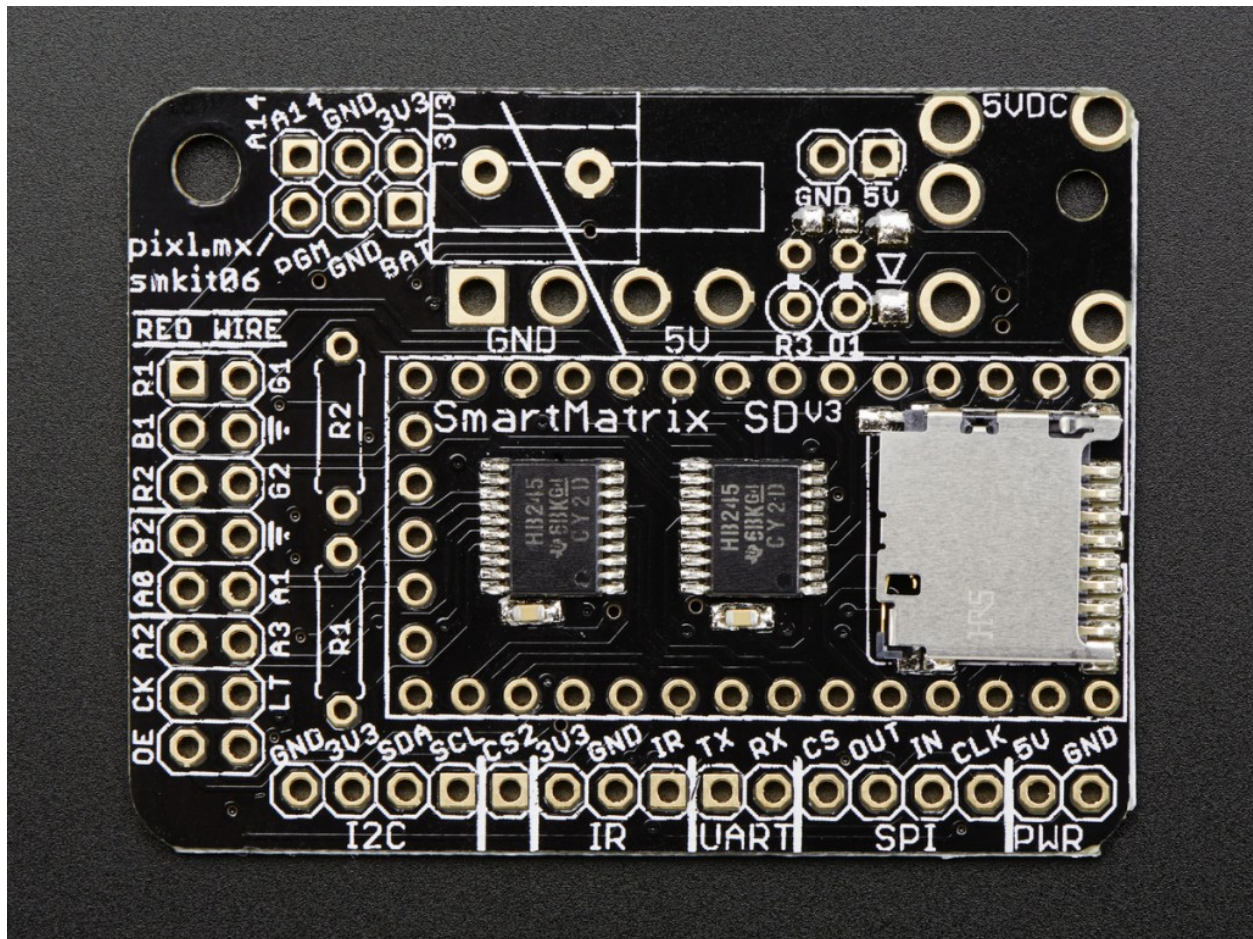


The software to run the Teensy is open source (more on that in Step 3) and the Teensy has a USB port which you connect to your computer which MPF uses to send the display data to the panels.

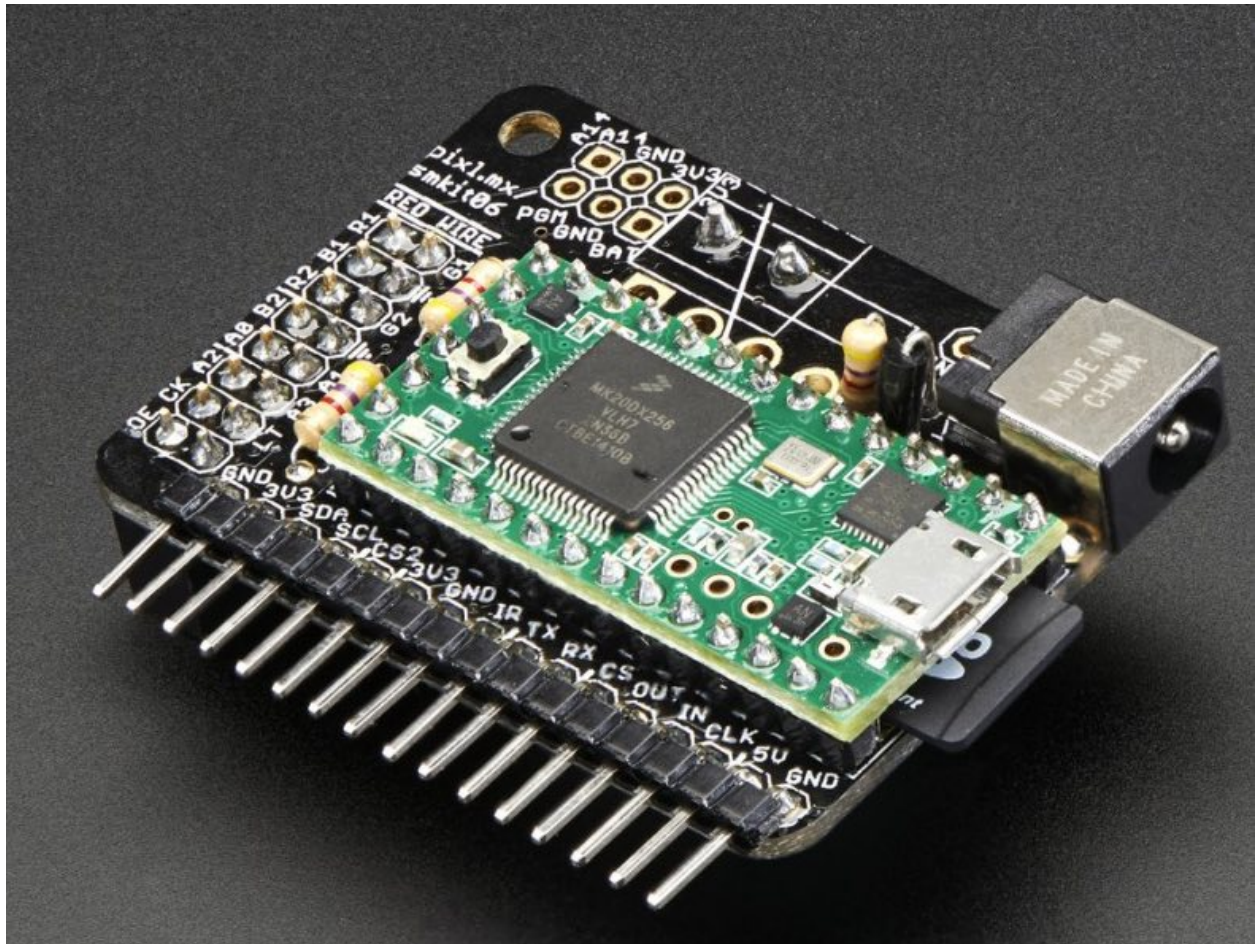
(3) The SmartMatrix Shield

Next you need a way for the Teensy to connect to the displays. That can be done with the SmartMatrix shield (\$15 from the guy who made the Teensy, though out of stock at the moment, so you might have to spend \$20 at Adafruit).

The SmartMatrix shield is a “dumb” device that basically just connects the Teensy’s GPIO pins to the 16-pin ribbon cable that drives the displays.



The Teensy mounts onto the SmartMatrix shield, creating a single unit which accepts data via USB on one end and spits out the 16-pin signal for the display panels on the other.



(4) The Power Supply

These RGB LED displays require 5vdc for power. At first you might think, “Cool! I have 5v elsewhere in my machine, so I’ll just tap into that!” Not so fast. These displays require *a lot* of power. After all, each pixel is actually three separate LEDs (one each for red, green, and blue), and a 128x32 display means that you have 4,096 pixels. So that’s 12,228 LEDs you need to power!

Since you’re ordering your RGB LED display panels from FAST Pinball, you can also order a [5v, 10A power supply](#) from them for \$19.



An ATX computer power supply will probably have a decent amount of amps also, so that could be an option too, just check the specs.

One thing about these RGB LED-based displays is they are bright. Like, really, really bright. (We're talking "burn your retinas if you stare straight at them" kind of bright.)

So even though you can do the math and read that if every pixel is on, full white, 100%, that might take more power than you have, there is no way you're going to run these things at full brightness.

Even at 50% brightness, (which would draw only 50% power) most people find these panels to be too bright. One user runs his at 25%, another at 18%. So it's possible that you might be fine with 5-7 amps of power.

You'll need to connect the power supply up to both panels (the 128x32 display is made up of two 64x32 panels), and while you're at it you can also use it to power your Teensy.

There's a trace you have to cut on the Teensy to control whether it's powered externally or by USB. Don't hook it up to external power if you haven't cut that trace!

2. Load the SmartMatrix code onto the Teensy

Once your hardware's built, you need to load the code onto the Teensy which receives the display data via USB and converts and sends it to the pins connected to the SmartMatrix controller. The people who make the SmartMatrix controller have code sample code available. We just took their sample code, removed all the clutter we don't need, and made it available in the tools folder in the MPF download package. (Here's a [direct link to the code](#) which you can use since you probably installed MPF via pip and don't have the download package available.

Also, [here's the original sample code](#) we based our code on.

Note that the width and height of your display is set in lines 11 & 12. You can change that if you want to use a different size display.

Mark Sunnucks was able to run a 128x64 display by setting the height there and also by changing the DMAs from 4 to 2 in line 14.

Also note that you can set the brightness of the display in this code too. You can control the brightness in MPF as well, but if you know for sure (maybe due to power limitations) that you never want the brightness to go over a certain amount, then you can set it here and it will be "hard coded" into your Teensy. (You can change this and re-flash your Teensy at any time.)

Here's a quick overview of how to install this code onto the Teensy. Full instructions are [here](#).

- Install the Arduino IDE v1.6.5
- Install the Teensyduino add-in which adds support for the Teensy
- Load the smart_matrix_dmd_teensy_code.ino sketch from the mpf/tools folder or [this link](#)
- Push the button on the Teensy to put it into programming mode
- Compile & load the code onto the Teensy from the Arduino IDE

3. Configure your SmartMatrix hardware settings

Once you have your hardware all set, you need to add a smartmatrix: section to your machine-wide config and which tells MPF how to talk to RGB DMDs that use the SmartMatrix platform.

The main thing you have to figure out is the port that the Teensy uses. On Windows, you can just open Device Manager and see which port appears when you plug in the Teensy.

On Mac or Linux, open up the terminal window and type the following command: `ls /dev/tty.*` The output of this command will look something like this on Mac:

```
/dev/tty.Bluetooth-Incoming-Port
/dev/tty.usbmodem1448891
```

Or this on linux:

```
/dev/ttyUSB0
/dev/ttyACM0
```


The port will be the one that has “usbmodem” in the name on Mac. On Linux it will probably be ttyUSBx or ttyACMx. (The actual number will likely be different on your system.) You can run this command with the Teensy unplugged, then plug it in, then run the command again, and see which port appears.

So on Windows, you’ll end up with something like:

```
hardware:
  rgb_dmd: smartmatrix

smartmatrix:
  port: com12
  baud: 2500000
  old_cookie: true
```

And on Mac or Linux, it will look something like:

```
hardware:
  rgb_dmd: smartmatrix

smartmatrix:
  port: /dev/tty.usbmodem1448891
  baud: 2500000
  old_cookie: true
```

Just enter the baud: and old_cookie: settings like they are in the example above. These are the settings that are needed for the SmartMatrix. If you are using the FAST DMD board set old_cookie to false and baud to 3000000.

3. Add a physical RGB DMD device entry

Once you have your SmartMatrix hardware platform set, you need to create the actual device entry for the RGB DMD and map it back to the SmartMatrix platform.

You do this in the `physical_rgb_dmds:` section of the machine config. This section is like the other common sections (switches, coils, etc.) where you enter the name(s) of your device(s), and then under each one, you enter its settings.

(And yes, in case you’re wondering, it’s possible to have more than one physical DMD.)

To do this, create a section in your machine-wide config called `physical_rgb_dmds:`, and then pick a name for the DMD, like this:

```
physical_rgb_dmds:
  my_dmd:
    platform: smartmatrix
    brightness: .17
```

There are several settings you can enter here. (See the [physical_rgb_dmds:](#) for details.) The only one you need to have is `platform: smartmatrix` which tells MPF that this RGB DMD should use the SmartMatrix hardware interface you configured in the previous step. (Otherwise if you don’t specify a platform, it will use the default platform which probably doesn’t support RGB DMDs. See the [Mixing-and-Matching hardware platforms](#) guide for details.)

You’ll probably also want to configure the brightness, which is a multiplier from 0.0 to 1.0 that’s applied to every pixel that’s sent to the DMD. In other words, the example of `brightness: .17` means

that each pixel will be shown at 17% brightness. (These things are crazy bright!)

Note: If you set the brightness multiplier in the sketch code .INO file you loaded onto the Teensy, then that will multiply the brightness after MPF sends it. In other words, if you set .5 in the config file and .5 in the sketch, then the final brightness will be 25%. You might want to set the absolute max brightness in the .INO file once and then fine-tune it via the config file later.

4. Set a source display

Now that you have everything configured, the last step is to make sure the DMD knows what content to show. In MPF, you do this by mapping a physical DMD to an *MPF display*.

By default, the DMD will look for a display (in your *displays:* section called “dmd”. However you can override this and configure the DMD to use whatever logical display you want by setting a `source_display:` setting. (Just make sure that the width and height of your source display match the physical pixel dimensions of the DMD or else it will be weird.)

A final config you can test

At this point you’re all set, and whatever slides and widgets are shown on the DMD’s source display in MPF-MC should be shown on the physical RGB DMD.

That said, all these options can be kind of confusing, so we created a quick example config you can use to make sure you have yours set right. (You can actually just save this config to `config.yaml` in a blank machine folder and run it to see it in action which will verify that you’ve got everything working properly.)

Note: Be sure to change the `smartmatrix:port:` setting in this example config to match whatever port your Teensy is connected to.

To run this sample config, you can either run `mpf both`.

When you run it, do not use the `-x` or `-X` options, because either of those will tell MPF to not use physical hardware which means it won’t try to connect to the Teensy.

Note that the *Using an RGB full-color LED DMD* guide has more details on the window and slide settings used in this machine config.

```
displays:
  window: # on screen window
    width: 600
    height: 200
  dmd: # source display for the DMD
    width: 128
    height: 32
    default: true

window:
  width: 600
  height: 200
  title: Mission Pinball Framework
```



```
smartmatrix:
  port: com5 # this will most likely be a different port for you
  baud: 2500000
  old_cookie: true

physical_rgb_dmds:
  my_dmd:
    brightness: .2
    platform: smartmatrix

slides:
  window_slide_1: # slide we'll show in the on-screen window
  - type: color_dmd # this widget shows the DMD content in this slide too
    width: 512
    height: 128
  - type: text
    text: MISSION PINBALL FRAMEWORK
    anchor_y: top
    y: top-3
    font_size: 30
    color: white
  - type: rectangle
    width: 514
    height: 130
    color: 444444
  dmd_slide_1: # slide we'll show on the physical DMD
  - type: text
    text: IT WORKS!
    font_size: 30
    color: red

slide_player:
  init_done:
    window_slide_1:
      target: window
    dmd_slide_1:
      target: dmd
```

RGB.DMD Controller

TODO

Using MPF with existing pinball machines (Williams, Stern, etc.)

TODO

Also link to spike here.

- Williams, Bally, Midway WPC, WPC-S, WPC-95
- Williams, Bally System 11
- Data East

- Stern Whitestar
- Stern SAM
- Stern SPIKE / SPIKE 2

How to use MPF with WPC machines

You can use MPF to control existing Williams / Bally / Midway WPC, WPC-S, and WPC-95 pinball machines.

1. Connecting the physical hardware

Your two options for pinball controller hardware are the Multimorphic P-ROC (not the P3-ROC) or the FAST Pinball WPC controller.

In both cases, you remove the existing MPU board from the backbox of your machine and replace it with the new controller. You then connect up all the existing cables and connectors to the new controller, so in effect the P-ROC or FAST WPC controller becomes the new MPU of your machine.

A few notes:

- Both the P-ROC and the FAST WPC controller have USB connections on them, and the actual “code” that makes up MPF runs on a computer which remotely controls the pinball controller (and therefore the machine)
- Switch connectors are connected directly to the P-ROC or FAST WPC controller.
- Drivers, coils, lamps, and GI are controlled via the existing WPC power driver board (which is connected to the P-ROC or FAST WPC controller via the existing 34-pin ribbon cable).
- The existing WPC sound board in the backbox is not used, as sounds are generated via the computer running MPF. There are articles online showing how you can modify the existing sound board to add a headphone plug you can connect into the computer running MPF, though most people end up replacing the speakers with new ones and a more powerful and better sounding amp. This means you can remove the existing sound board from the backbox.
- The existing DMD, if you choose to use it, is unplugged from the WPC DMD driver board and instead plugged into a 14-pin header on the P-ROC or FAST WPC controller. This means you can remove the existing DMD driver board from the backbox.

2. Configuring MPF for WPC machines

In order to use MPF in a WPC machine, you need to configure the driverboards: section of your hardware: config for MPF.

If you’re using a FAST WPC controller, it will look like this:

```
hardware:
  platform: fast
  driverboards: wpc
```

And if you’re using a P-ROC:


```
hardware:
  platform: p_roc
  driverboards: wpc
```

Note that with the P-ROC, it is *very important* that you specify `driverboards: wpc` in your config if you're using a WPC machine. The reason for this is the P-ROC can be used to control either PD-16 (the P-ROC driver boards) or WPC driver boards, but the polarity of each type is the inverse of the other.

In other words, if you put a P-ROC in a WPC machine but specify `driverboards: pdb`, when you run MPF, it will disable all the drivers, but since the polarity is reversed, it will actually enable every driver in your machine at once. This will (1) be very loud and cause you to jump back about 10 feet, and (2) blow all your fuses.

3. Configuring switches

When using MPF with WPC machines, you can use the switch numbers from the machine's operator's manual. The exact format depends on the type of switch:

Matrix switches

Matrix switches start with the letter S, followed by the switch number. For example:

```
switches:
  s_left_slingshot:
    number: s41
  s_right_jet:
    number: S45
```

Note that the "S" is not case-sensitive.

Switch numbers in WPC machines correspond to the column and row, so switch "11" is column 1, row 1, switch "26" is column 2, row 6, etc. This means that there are no 0s or 9s in a standard 8x8 switch matrix.

Also, some WPC-95 machines have a 9th column in the switch matrix (meaning they'll have switch numbers 91-98). In this case, just enter those switch numbers like normal, and MPF will notice that there are switch numbers in the 90s and automatically configure the controller hardware to use the 9th column.

Our experience with using MPF with many different WPC machines is that many times, the switch numbers in the operator's manual are incorrect. (We see this in many 25% of WPC machines.) Usually it's the case where two switches have been swapped, though sometimes there are unused switches that really are used and vice-versa. So if you don't get switch activities that you expect, check out neighboring switches to see if the numbers are wrong.

Direct switches

Direct switches (which are typically the coin and front door switches) are entered with the SD prefix, then the number, like this:


```
s_left_coin:
  number: sd1
s_enter:
  number: SD8
```

Again, case doesn't matter.

Fliptronics switches

Fliptronics switches (on machines that have them) are entered with the SF prefix.

There are 8 Fliptronics switches on machines with Fliptronics. Typically four of them are used for flipper buttons, and four are used for EOS switches. (The flipper buttons on most Fliptronics machines actually have two switches stacked together behind each flipper button. If you push the flipper button part way in, the switch connected to the lower flipper engages, and if you push the button the rest of the way in, the switch connected to the upper flipper engages. This means if you're good, it's technically possible to flip just the lower flipper without flipping the upper one (or it's possible to hold a ball on the lower flipper while flipping the upper one).

That said, some machines needed a few extra switches for other things, and if they don't have four flippers, it's possible that the extra Fliptronics switches are used for other things.

You would use Fliptronics switches in your config like this:

```
switches:
  s_flipper_lower_right_eos:
    number: sf1
  s_flipper_lower_right:
    number: sf2
    tags: player, right_flipper
  s_flipper_lower_left_eos:
    number: sf3
  s_flipper_lower_left:
    number: sf4
    tags: player, left_flipper
```

4. Configuring coils & drivers

The drivers section of your WPC machine's operators manual will list all the driver numbers as well as the devices they're attached to. Note that WPC machines use drivers for coils, motors, and flashers. You only enter your coils and motors in the coils: section of your config. Flashers go in the flashers: section (discussed below).

Configuring regular coils

To configure the regular coils (from the "Solenoid / Flasher" table in your machine's operator's manual, enter the letter C followed by the solenoid number, like this:

```
coils:
  c_trough_eject:
    number: c01
```



```

pulse_ms: 25
c_bottom_popper:
  number: c02
  pulse_ms: 25
c_plunger_lane:
  number: c03
  pulse_ms: 25

```

Fliptronics coils

You'll also see a section in the solenoid table in your operator's manual with "Flipper Circuits", like this:

Flipper Circuits		
(29)		Lwr. Rt. Power
(30)	Lower Right Flipper	Lwr. Rt. Hold
(31)		Lwr. Lt. Power
(32)	Lower Left Flipper	Lwr. Lt. Hold
(33)	Claw Magnet	Up Rt. Power
(34)	Not Used	Up Rt. Hold
(35)		Up Lt. Power
(36)	Upper Left Flipper	Up Lt. Hold

That section shows the 8 driver outputs that are connected to the Fliptronics board (if your machine has one).

For those coil numbers, you can either enter C followed by the number, or the four-letter code indicating which output the driver is connected to, like this:

- c29 or FLRM - Lower Right Main (Power)
- c30 or FLRH - Lower Right Hold
- c31 or FLLM - Lower Left Main (Power)
- c32 or FLLH - Lower Left Hold
- c33 or FURM - Upper Right Main (Power)
- c34 or FURH - Upper Right Hold
- c35 or FULM - Upper Left Main (Power)

- s36 or FULH - Upper Left Hold

Many machines do not use all eight of these, and many machines also connect Fliptronics coils up to other random things (typically magnets and diverters).

An example in your config might be:

```
coils:
  c_flipper_left_main:
    number: fl1m
    pulse_ms: 30
  c_flipper_left_hold:
    number: fl1h
    allow_enable: true
  c_flipper_right_main:
    number: fl1r
    pulse_ms: 30
  c_flipper_right_hold:
    number: fl1h
    allow_enable: true
  c_vanish_magnet:
    number: c35
    allow_enable: true
  c_loop_post_diverter:
    number: c36
    allow_enable: true
```

5. Configuring lights (lamps)

Lights are configured with the letter L followed by the lamp number from the manual:

```
matrix_lights:
  l_ball_save:
    number: l11
  l_fortress_multiball:
    number: L12
  l_museum_multiball:
    number: L13
  l_cryoprison_multiball:
    number: l14
  l_wasteland_multiball:
    number: L15
  l_shoot_again:
    number: l16
```

5. Configuring GI (general illumination)

GI strings are configured with G followed by the number, like this:

```
gis:
  gi_back_panel:
    number: g01
  gi_upper_right:
```



```
number: g02
gi_upper_left:
  number: g03
gi_lower_right:
  number: g04
gi_lower_left:
  number: g05
```

6. Configuring flashers

Since flashers in WPC machines are technically drivers (coils), they are also configured with the letter C followed by their number. However, you add them to the `flashers:` section of your config, not the `coils:` section. This is done so MPF knows to treat them like flashers which are just pulsed, rather than coils which can be enabled and have other coil-like things that don't apply to flashers.

```
flashers:
  f_claw:
    number: c17
  f_jets:
    number: c21
  f_side_ramp:
    number: c22
  f_left_ramp_upper:
    number: c23
  f_left_ramp_lower:
    number: c24
```

Stern Whitestar

Todo

Using MPF without physical hardware

It's possible to run MPF even if you don't have a physical pinball machine attached to your computer. This is great if you're just starting out, or if you want to work on your MPF config when you're not around your pinball machine.

MPF achieves this through "virtual" platform interfaces, of which there are two options:

Note that if you want to use MPF without a physical pinball machine, you probably also want to use the [MPF Monitor](#) which is a graphical tool that lets you interact with lights, switches, and pinball mechs in MPF which works nicely with the smart virtual platform.

The "Smart Virtual" Platform

MPF's *Smart Virtual Platform* is based on the [virtual platform](#) with one key difference: The Smart Virtual platform watches for coil pulse events and adjusts switches in response to simulate how those switches would have changed if that coil fired on real hardware.

To understand why the smart virtual platform exists, consider this simple machine config for a trough, a plunger lane, and keyboard key mappings to simulate their switches:


```
switches:
  s_trough1:
    number: s31
  s_trough2:
    number: s32
  s_trough3:
    number: s33
  s_trough4:
    number: s34
  s_plunger_lane:
    number: s27

coils:
  c_trough_eject:
    number: c01
    pulse_ms: 25
  c_plunger_eject:
    number: c03
    pulse_ms: 25

ball_devices:
  bd_trough:
    tags: trough, home, drain
    ball_switches: s_trough1, s_trough2, s_trough3, s_trough4
    eject_coil: c_trough_eject
    eject_targets: bd_plunger
  bd_plunger:
    ball_switches: s_plunger_lane
    eject_coil: c_plunger_eject
    tags: ball_add_live

keyboard:
  1:
    switch: s_trough1
    toggle: true
  2:
    switch: s_trough2
    toggle: true
  3:
    switch: s_trough3
    toggle: true
  4:
    switch: s_trough4
    toggle: true
  p:
    switch: s_plunger_lane
    toggle: true
```

MPF's regular virtual platform interface is "dumb" in the sense that all switch actions need to be controlled externally (either via keyboard keys, the OSC interface, etc.)

So if you have the above configuration and then MPF wants to eject a ball from the trough, it will fire the trough coil but the switches won't actually change. (In fact this will cause MPF to think that the eject failed, because it will fire the eject coil and not see the ball leave.)

If you wanted to "play" an MPF game with the example config above, you'd have to manually manually

simulate the ball leaving the trough by hitting the “1” key to deactivate a trough switch, and then hitting the “P” key to activate the plunger lane switch. (And you’d have to do this fast enough for the eject failure detection not to kick in.)

A better solution? The “smart” virtual interface.

In order to address these challenges, MPF includes a smart virtual platform interface. The smart virtual interface works by watching for coil pulse commands. If it sees a coil pulse from a coil that’s configured in a mechanism that would ordinarily cause a switch to change state, then it will automatically change that switches state.

For example, if you have the trough config from above and the trough’s eject coil fires, the smart virtual platform will look to see if there are any balls in that device, and, if so, simulate the ball leaving (which could be by deactivating one of the device’s ball switches).

The smart virtual platform also knows (thanks to the *eject_targets*: ball device setting) where the ball is ejected to, so when a ball is ejected from a device, the smart virtual platform will also simulate the ball going into the target ball device.

Going back to the example machine config above, if the smart virtual platform interface is being used, when a game is started, you’ll see the *s_trough1* switch automatically deactivate in response to the trough coil pulsing, and then 100ms later you’ll see the *s_plunger* switch activate to simulate a ball going into the plunger lane. So simply starting a game with the smart virtual platform puts the ball in the plunger lane without you having to mess with the “1” and “P” keys.

Using the smart virtual platform

There are three ways you can use the smart virtual platform:

1. No platform setting

If you do not have a `platform:` setting in your machine config’s `hardware:` section (or if you don’t have a `hardware:` section, then MPF will use the smart virtual platform anyone you run it.

2. Manually setting the platform

You can also manually specify the smart virtual interface in the machine config, like this:

```
hardware:
    platform: smart_virtual
```

3. Via the command line

You can also specify the smart virtual platform interface via the `-X` (uppercase *X*) from the command line, like this:

```
mpf -X
```

Or


```
mpf both -X
```

etc.

What does the smart virtual platform do?

The smart virtual platform currently simulates the following pinball mechanisms:

Ball Devices

If a ball device's eject coil is pulsed, it will simulate a ball leaving that device (as long as that device has at least one ball). It is smart enough to know how many balls are in a device, and works with special scenarios (such as timed entrance switches that are only active when the device is full and eject confirmation switches).

It will also simulate a ball entering the target device when a ball is ejected, and again it knows how to work with various ball switch and entrance switch combinations.

Drop Targets

The smart virtual platform will reset drop target switches if their associated reset coil is pulsed.

The Virtual Platform

MPF's virtual platform interface is a software-only platform you can use if you don't have a physical pinball controller attached.

Note: MPF also has a [smart virtual platform](#) which is probably what you'd use in most cases instead of the virtual platform.

Note for P-ROC and P3-ROC users: P-ROC's pyprocgame includes a virtual P-ROC interface called *FakePinPROC*. We don't use that in the MPF because doing so requires that pyprocgame is installed, and it's likely that people using MPF won't have pyprocgame. Using MPF's virtual hardware interface is conceptually similar to *FakePinPROC*.

Using the virtual platform

There are three ways you can use the virtual platform:

1. Manually setting the platform

You can manually specify the virtual platform in the machine config, like this:

```
hardware:
    platform: virtual
```


3. Via the command line

You can also specify the smart virtual platform interface via the `-x` (lowercase *X*) from the command line, like this:

```
mpf -x
```

Or

```
mpf both -x
```

etc.

Choosing a PC for MPF

In addition to picking a pinball controller platform, you also need to decide what type of host computer you'll use. (By "host computer," we're talking about the computer that will run MPF which will talk to the pinball controller via USB.) There are lots of host computer options, including small single-board computers, laptops, small-form factor x86 motherboards, etc. You're also going to have to decide on what OS you use (Windows, Linux, or Mac).

Generally speaking, MPF will run on any PC or embedded system which can run Python 3. In most cases you also need a graphics card with working OpenGL to run the MPF Media Controller (MPF-MC). Most operating systems work fine (we test on Linux, Windows, Mac OS X) but be careful with virtualized environments because OpenGL might not work perfectly.

What kind of performance is required?

One of the biggest things that will affect your choice of host computer will be the performance you need. Obviously the host computer has to "keep up" with your game, so if you pick an under-powered host computer then your game loop can slow down and you'll have issues. The computing needs of a pinball machine are actually pretty small. The core game, modes, ball tracking, dealing with switches, etc.—all of that can probably be done on a very tiny computer. The real driver these days is your video and graphics. If you have a hi-def LCD window with lots of full video and layers and on-screen elements all blended together, then you're going to need a "real" computer to drive it and will not be happy with a small single-board computer.

CPU

The trend in computing these days (for both "real" computers and small single-board computers) is multi-core. Almost every computer these days has a dual-core or quad-core processor.

MPF uses two processes (one for the game engine and one for the media controller), so it can make use of a dual-core system. However there is probably not much benefit to MPF running on machines with more than 2 cores (other than it frees up more cores for other non-MPF things.) During startup, when playing sound or loading assets additional cores may be used. Therefore, we recommend a CPU with at least two cores. MPF certainly benefits from four cores but everything above that will not help during normal games. However, during development, when using MPF Monitor and an IDE more cores will certainly help.

Disk

Disk space is not really an issue these days. The real question is disk performance in terms of SSD versus traditional spinning magnetic hard disks. SSD is fast, you can get away with less memory since MPF can dynamically load and unload assets. To load assets quickly a SSD helps. You definitely want that during development but you might use a cheaper option (such as a SD-card) for the final game.

Filesystems can become corrupted by unsafe shut downs, so consider running a journaling filesystem or even mount them read-only.

Memory

MPF itself doesn't require much memory. The real memory use comes from loading all the images, sounds, and videos into memory. MPF can load those on demand (or automatically when a mode starts, and unload them when the mode ends). This works well if you have a fast disk (SSD).

However, if you have enough memory, MPF can pre-load everything when it starts. This will increase the startup time of your machine, but will make it so that everything runs fast once its booted.

Note that 32-bit OSes only allow individual applications to access 2GB of memory, so if you have 6 gigs of assets and want to buy a machine with 8GB of RAM, you need to run a 64-bit OS. (MPF supports both 32-bit and 64-bit systems. If you run on 64-bit, make sure you also get the 64-bit version of Python.)

MPF needs at least 512MB RAM but we recommend 2-4GB depending on the amount of assets. Again, during development you want to have more RAM (8GB+) for your IDE and other tools.

Development setup

- CPU with at least four cores
- 8GB RAM or more
- SSD

Final game

We cannot emphasize this enough: Do not use such a setup for game development.

- CPU with two to four cores
- 2-4GB RAM (mostly for assets)
- SD-Card/Embedded flash/SSD

See also the [*discussion about the hardware in your final game*](#).

Other

TODO

How MPF handles “quick response” mechs (flippers, slingshots, etc.)

As you can imagine, many types of mechanisms in a pinball machine require near “instant” response to switches. For example, you do not want any “lag” between the time you press the flipper button and the time the flipper physically moves.

To address this, MPF and the control systems handle “quick response” devices in a special way. This includes things like:

- flippers
- pop bumpers
- slingshots
- kicking targets
- kickback lanes
- diverters
- and maybe others?

What’s the problem?

To understand why MPF and the hardware control systems work this way, first think about how MPF works in general.

When you configure (and enable) a flipper in MPF, what you’re really doing is saying, “when this switch becomes active, fire this coil” (and do that as fast as possible).

The challenge is that MPF is software running on a computer connected to a pinball control system via USB. So if you think about the entire process that needs to happen to flip a flipper, you have:

1. The hardware control system is continuously scanning switches to see if they change state.
2. The player pushes the flipper button.
3. The hardware control system notices the change.
4. The hardware control system adds the message with the switch state change to the queue to be sent to the computer via USB.
5. The computer processes the USB message.
6. MPF gets notification of the switch change.
7. MPF looks at its configuration and notices that a coil should be fired.
8. MPF creates the instruction to fire the coil.
9. That instruction is put in the queue to be sent to the hardware controller via USB.
10. The USB bus transfers that command to the hardware controller.
11. The hardware controller receives that command and fires the coil attached to the flipper.

Of course computers are really fast, and this can all happen in 10 or 20ms. But again, with the desire for “instant” response of these devices, that isn’t fast enough.

The solution? “Hardware rules”

So the way this is handled is that all the pinball control systems have the ability to have simple “rules” written to them which lets them do simple things on their own.

These rules are very simple and only involve switches and coils. For example, a rule might be “when this switch is activated, pulse that coil”, or “when this switch is released, cut off the power to that coil”.

Then when one of these “hardware rules” (as we call them in MPF) is written to the hardware pinball controller, that controller can handle it all by itself with minimal delay (usually in a millisecond or two) without having to deal with USB and MPF and all that.

These rules are *not* permanently stored on the hardware controller, and in fact they’re constantly added, removed, and updated throughout the course of a game. (Rules for flipper buttons and coils are removed when a ball ends and added when a ball starts, etc.)

By the way, even when MPF writes hardware rules to the pinball controller, the switch notification is still sent to MPF (since you might want to have scoring or play a sound or something when that switch is hit). It’s just that in that case, the switch notification is sent to MPF for MPF’s game logic purposes, but the actual coil firing would have already happened thanks to the hardware rule on the pinball controller.

This is all automatic

The good news about these hardware rules is that there’s nothing you need to do to use them. This is just one of the things that MPF does behind the scenes, thanks to the smart people who designed the pinball controllers.

How to configure “number:” settings

All of the physical “hardware” mechanisms in MPF config files have a `number:` setting which is used by the hardware platform to know which device is which.

Since MPF supports many different types of hardware, the exact way you configure the “number” entry depends on what type of device and what type of hardware you’re using.

We have full guides that explain it all in the hardware controller documentation, but here are the links all in one place to make it easy.

Switches

- [*FAST Pinball*](#)
- [*P-ROC*](#)
- [*P3-ROC*](#)
- [*Open Pinball Project \(OPP\)*](#)
- [*Stern SPIKE*](#)
- [*Snux \(System 11\)*](#)

Drivers / Coils

- *FAST Pinball*
- *P-ROC / P3-ROC*
- *Open Pinball Project (OPP)*
- *Stern SPIKE*
- *Snux (System 11)*

LEDs

- *FAST Pinball*
- *P-ROC / P3-ROC (PD-LED)*
- *Open Pinball Project (OPP)*
- *Stern SPIKE*
- *FadeCandy*

Lamp Matrix-based lights

- *FAST Pinball (WPC Machine)*
- *P-ROC / P3-ROC (PD-8x8)*
- *P-ROC (WPC Machine)*
- *P-ROC (Stern SAM / Whitestar)*
- *Open Pinball Project (OPP)*
- *Snux (System 11)*

Servos

- *FAST Pinball (Servo daughterboard)*
- *P3-ROC (I2C servo controller)*
- *Pololu Maestro*

Mixing-and-Matching hardware platforms

In MPF it's possible to mix-and-match your hardware platforms. For example, you could use a P-ROC for your coils and switches while using a FadeCandy for your LEDs. (Or, if you wanted to be crazy, you could use a FAST controller for your switches and a P-ROC for your coils and lamps.)

You can specify hardware platforms in three ways:

1. Machine-wide default platform

Whatever you set in the hardware: platform: section of your machine-wide config is the default platform for all types of mechanisms across all of MPF.

For example:

```
hardware:
  platform: p_roc
  driverboards: pdb
```

In the above config, the P-ROC platform will be the default for everything. (switches, coils, lights, LEDs, DMDs, servos, etc.)

2. Device-specific default platform

If you want to specify a default for a certain class of devices that is different than the machine-wide default, you can also do that in the hardware: section by adding an entry for the type of device you want to specify the default for.

For example, if you want to use a P-ROC as the default for everything except for LEDs, which you want to be FadeCandy, you would do it like this:

```
hardware:
  platform: p_roc
  driverboards: pdb
  leds: fadecandy
```

You can enter a device-specific default for the following types of devices here:

- coils:
- switches:
- matrix_lights:
- leds:
- dmd:
- rgb_dmd:
- gis:
- flashers:
- servo_controllers:
- accelerometers:
- i2c:

3. Overriding the platform of individual devices

Finally, you can override the platform of an individual device by adding a platform: setting to that device.

For example, if you're using a FAST Pinball controller which can control up to 256 LEDs, but you also want to add some more LEDs that will be attached to a FadeCandy, you could set up your config like this:

```
hardware:
  platform: fast

leds:
  led00:
    number: 0-0
  led01:
    number: 0
    platform: fadecandy
```

In this example, *led00* will use the FAST platform (and the number 0-0 is a FAST configuration number), and *led01* will use the FadeCandy platform (and the number 0 is a Fadecandy number).

You could also invert this, like so:

```
hardware:
  platform: fast
  leds: fadecandy

leds:
  led00:
    number: 0-0
    platform: fast
  led01:
    number: 0
```

In the example above, *led00* is still a FAST LED and *led01* is still a FadeCandy LED, but the difference is that while the default platform is FAST, the default platform for LEDs is FadeCandy. That means you don't have to specify the platform for LEDs attached to the FadeCandy, but you do need to specify the platform for LEDs attached to the FAST controller.

Pinball Mechanisms

MPF supports all the various pinball hardware mechanisms you'd expect. Some of these are basic (switches, LEDs, coils), and others are built up by combining multiple simpler mechs (Switch X plus Coil Y = Flipper 1, etc.)

Pinball mechs can be configured in either machine-wide or mode-specific config files. Each one has a name, and there are configuration options for each which control exactly how it behaves (or how its behavior changes depending on what's going on in your game).

Pinball Mechs in MPF include:

Accelerometers

Related Config File Sections

[*accelerometers:*](#)

- [*Monitorable Properties*](#)
- [*Related How To guides*](#)
- [*Related Events*](#)

An accelerometer is a device that measures proper acceleration; proper acceleration is not the same as coordinate acceleration (rate of change of velocity). For example, an accelerometer at rest on the surface of the Earth will measure an acceleration due to Earth's gravity, straight upwards (by definition) of $g \sim 9.81 \text{ m/s}^2$. By contrast, accelerometers in free fall (falling toward the center of the Earth at a rate of about 9.81 m/s^2) will measure zero.

Accelerometers in pinball could be used to measure a machine's TILT, replacing the tilt bob, to measure vibration, or even the angle of the playfield at a given time.

Learn more at: <https://en.wikipedia.org/wiki/Accelerometer>

Monitorable Properties

For *dynamic values* and *conditional events*, the prefix for accelerometers is `device.accelerometers.<name>`.

value A three-item tuple (x, y, z) of the current accelerometer values.

Related How To guides

Todo: TODO

Related Events

None Varies based on the configured (you can configure events to be emitted when certain G-force thresholds are exceeded).

Autofire Coils

Related Config File Sections

<i>autofire_coils:</i>
--

- [*First, some background...*](#)
- [*How MPF interacts with autofire rules*](#)
- [*How MPF handles autofire rules*](#)
- [*Monitorable Properties*](#)
- [*Related How To guides*](#)
- [*Related Events*](#)

An autofire coil in MPF is used for “instant response” type devices (like pop bumpers and slingshots) where you want a switch activation to trigger a coil as close to instantaneous as possible.

First, some background...

The Mission Pinball Framework is based on Python. Running a “real” pinball machine means you have some kind of computer-like board running Python (Mini ITX x86 computer, Raspberry Pi 3, etc.) which runs your game, controls the display, and plays your sounds. That computer connects to your hardware controller (P-ROC, FAST, etc.) to interface with your actual pinball machine components (switches, coils, lights, motors, LEDs...).

There are several types of devices in a pinball machine that you want to react “instantly.” For example, when a switch in a slingshot or pop bumper is activated, you want the coil to fire as fast as possible. When the player pushes a flipper button, you want that flipper to fire instantly, and when the player releases the flipper button, you want the machine to cut power to that flipper coil instantly. Unfortunately if you think about what the flow chart of activity looks like for that to happen, there are a lot of steps. (And it’s certainly not instant.) For example, imagine what happens when a ball hits a slingshot:

1. The slingshot switch is activated.
2. The hardware controller debounces that switch.
3. The hardware controller sends a notification that the slingshot switch changed state to your Python game code via USB.
4. Something in your code says, “if the slingshot switch is activated, fire the slingshot coil.”
5. The Python game code sends the “fire the slingshot coil” command to the hardware controller via USB.
6. That command is queued on the USB bus and transmitted.
7. The hardware controller fires the slingshot coil.

Wow! That’s a lot of steps just to fire a coil when a switch is hit! Unfortunately the entire process of all this going from the hardware to the computer to the game code to the hardware to the coil takes some time—maybe 10ms or so. But with a fast moving pinball you might find that it’s not fast enough. (What if your game code was in the middle of updating a bunch of lights and that delayed it another 5ms?) You might find that by the time your game code gets around to firing the coil it’s too late. In effect your slingshot firing has lag and might miss the ball altogether. Not good!

Fortunately the people who designed the hardware controllers know this, so they have options where “autofire” or “trigger” rules can be written into the hardware controller which the hardware controller can handle on its own. In the Mission Pinball Framework, we call these types of rules “Autofire” rules, because we specify that a coil fires automatically based on some switch event without any involvement of our host computer or the Python game code.

To use an autofire rule, you specify the name of a switch, the state of the switch (whether it goes active or inactive), the name of a coil or driver, and what you want that coil to do. (Turn on, turn off, pulse for a certain number of milliseconds, receive a pwm pulse pattern, etc.)

So for example, if you want to configure a slingshot, you might use a rule on your hardware controller which says, “when switch *left_slingshot* goes active, fire coil *left_slingshot_coil* for 30ms.” Or you might have a rule which says, “When switch *right_flipper* becomes inactive, cut power to the coil called *right_flipper_hold*.”

You can set any combination of rules you want onto a hardware controller. In fact, MPF will use several individual rules on the same set of switches and coils to do what might seem like simple things. For example, think about what rules you’d need for a dual-wound (power and hold windings) flipper coil:

- When the flipper button becomes active, enable the power coil.
- When the flipper button becomes active, enable the hold coil.
- When the EOS switch becomes active, disable the power coil.
- When the flipper button becomes inactive, disable the hold coil.

- When the flipper button becomes inactive, disable the power coil. (We need this one to “cancel” the flip action if the player releases the flipper button before the flipper hits the EOS switch at the top of its stroke.)
- If the flipper button is active *and* the EOS switch becomes inactive, enable the power coil. (This causes the flipper to go back to the “up” position if for some reason it comes down when the player is holding the flipper button.)

Now look at that above list. That’s six rules just for one flipper! If you have four flippers in your game, you’ll have 24 autofire rules just to get your flippers set up!

Fortunately MPF makes this easy and hides the complexity from you. :)

How MPF interacts with autofire rules

The hardware controllers in your pinball machine have no concept of what your game code is doing at any given time. (Actually they don’t even know what a “game” is, or really what a “pinball machine” is.) They just know that they have rules programmed into them, and those rules specify what instantaneous actions they should take based on certain switches changing state. So your game code can overwrite rules at any time (and as often as you want) to overwrite existing rules with new actions. For example, if your player tilts the machine, then you need to disable the flippers. To do so you would overwrite the above six rules with the following:

- When the flipper button becomes active, do nothing.
- When the flipper button becomes inactive, do nothing.
- When the EOS switch becomes active, do nothing.
- When the EOS switch becomes inactive, do nothing.

And just like that, your flippers are disabled! You can also see how you can use these autofire rules to do all sorts of fun things, like reversing the flippers (so the right button controls the left flipper and vice versa), or making “no hold” flippers, or inverting the flipper buttons so pushing them in disables the flippers and letting go enables them. :)

The final thing that’s important to know about these autofire rules you program into your hardware controller is that they do not prevent the hardware controller from doing everything else it might do. For example, if you have a pop bumper then you will probably install an autofire onto your hardware controller that causes the pop bumper coil to fire instantly to knock the ball away.

When that rule is installed, the hardware controller will do two things when the pop bumper switch is activated. First, it will fire the coil, but second, it will also notify MPF that the pop bumper switch was hit (since it notifies your game of any switch that was hit). Then your game code can respond how you want, perhaps by scoring some points and playing a sound effect. When this happens, *technically speaking* they won’t happen at the same time. The hardware controller will probably fire the coil in under 1ms, and it might take your game code 5 or 10ms to add the score and play the sound. But that’s fine. 10ms is still 1/100th of a second and no human player is going to notice that delay. (Heck, the speed of sound is so slow it takes another 1/100th of a second for the sound wave to travel from your machine’s speaker in the back box to the player’s ear!)

The point is that just because you install autofire rules doesn’t mean you can’t also service those switches in your game code. It’s just that you end up dividing the duties—the hardware controller handles the coil responses on its own, and you handle audio and scoring in your game code.

Oh, by the way, it’s not like you need to use these autofire rules for *all* your coil activity. Most things like ejecting balls, resetting drop targets, and firing your plunger can all be handled in your game

code because in those cases you don't care about the extra 1/100th of a second delay. You only need autofire rules for things you want to happen instantly, which is usually only pop bumpers, slingshots, and flippers.

How MPF handles autofire rules

Now that you just read 1500 words on how autofire rules work, the good news is that you don't really have to worry about these details of them when using the Mission Pinball Framework. In MPF, you use the configuration files to setup devices like pop bumpers, slingshots, and flippers, and the framework handles all the autofire hardware rule programming based on the switches and coils you specify in your config files.

In fact the framework automatically creates lists of your devices and gives them `enable()` and `disable()` methods, so rather than having to know all the intricacies of all those different rules, enabling your flippers is as simple as `self.flippers.enable()`. Nice! (But if you dig through the source code you'll see that the framework uses all these rules behind the scenes.)

You can also configure autofire coils manually for simpler things like pop bumpers and slingshots. See the [autofire_coils: section of the configuration file reference](#) for details.

Monitorable Properties

For [dynamic values](#) and [conditional events](#), the prefix for autofire coils is `device.autofires.<name>`.

enabled Boolean (true/false) which shows whether this autofire coil is enabled.

Related How To guides

- [Tutorial step 13: Add slingshots, pop bumpers, and other “autofire” devices](#)

Related Events

None The autofire coils can be configured to enable or disable based on other events)

Ball Devices

Related Config File Sections
ball_devices:

- [Monitorable Properties](#)
- [Related How To guides](#)
- [Related Events](#)

A *ball device* is any physical thing in a pinball machine which is able to hold (i.e. “capture”) a ball and then release it. (Either automatically or based on some action by the player.) Examples of ball devices include the trough, the plunger lane, VUKs, poppers, playfield locks, etc.—basically anything that can hold a ball. (Even the playfield is technically a ball device since balls rolling around are “in” the playfield device.)

Ball devices are usually made up of switches (which are typically used to count how many balls the ball device has) and coils (which are typically used to eject a ball from a device.) Most games have several ball devices. At a minimum they’ll have the device that holds the ball when it drains and the playfield.

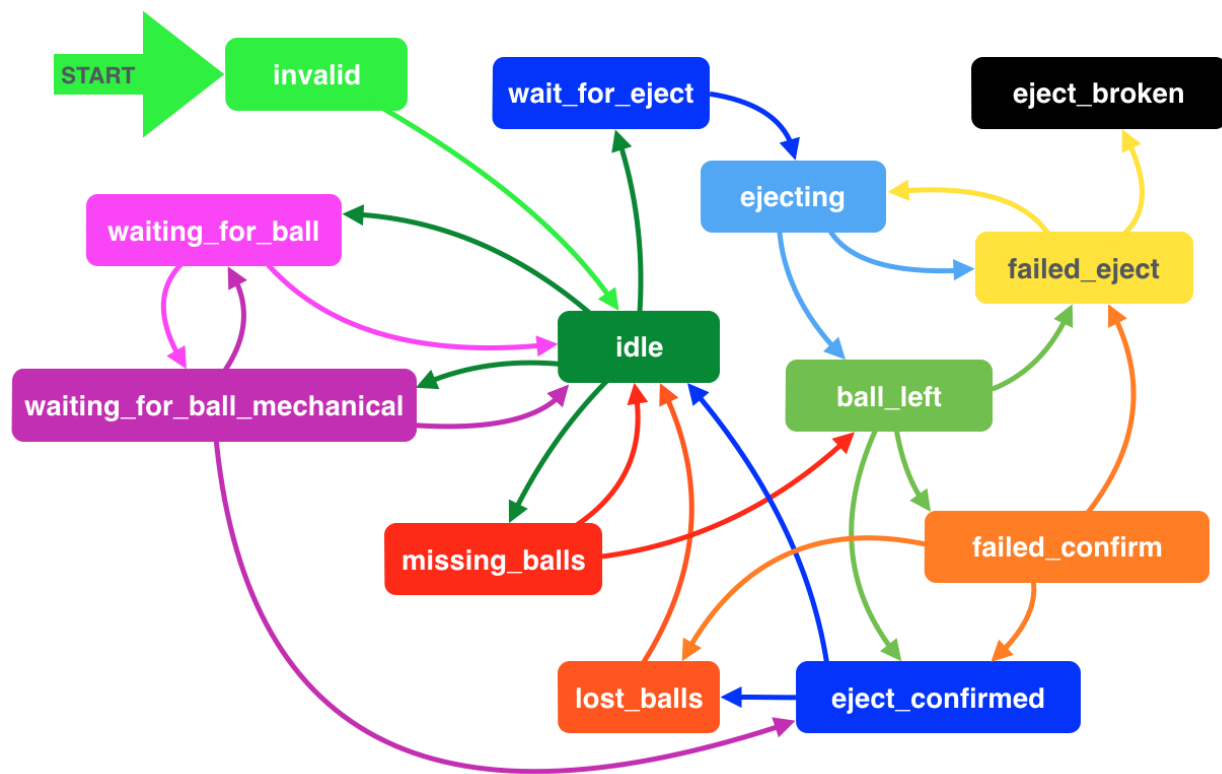
Ball devices are probably the most important element of MPF (because no one likes it when a machine gets confused about where the balls are) and something we’ve spent a lot of time on. They work hand-in-hand with MPF’s Ball Controller to keep track of where all the balls are at any given time.

In MPF, ball devices are implemented as [finite state machines](#).

Each ball device is responsible for managing its own state, which can be:

- idle
- missing_balls
- waiting_for_ball
- waiting_for_ball_mechanical
- ball_left
- wait_for_eject
- ejecting
- failed_eject
- eject_confirmed

Here’s a diagram which shows the relationships between the various states. A device can only transition from its current state to one of the states an arrow is connected to.



When you configure ball devices in MPF, you configure the list of other devices that a ball device can eject to. This allows MPF to have an understanding of the “chain” of devices and enables it to route balls to where they need to go. (*Diverters* also figure into this chain, meaning MPF can ensure that diverters are set properly as it’s routing balls around.)

Here’s a simplified example of how the “chain” of ball devices works:

A simple modern machine would have a minimum of three ball devices:

- The trough
- The plunger lane
- The playfield (remember in MPF, the playfield is technically a ball device)

When you configure your ball devices, the trough is configured so that the plunger lane is its eject target, the plunger lane is configured with the playfield as its eject target, and the playfield is configured to know that it drains into the trough. So you have a complete loop of devices.

This means that, for example, if the playfield wants another ball (like for a multiball), MPF knows that the playfield gets balls from the plunger lane, and if the plunger lane doesn’t have a ball, MPF knows that the plunger lane can get a ball from the trough.

Pretty cool!

Of course in a real machine, you’ll have a lot more than the three ball devices listed above.

Picking a random machine as an example, *Judge Dredd* has eight(!) ball devices:

1. The trough
2. The right plunger lane
3. The left plunger lane

4. The Sniper VUK
5. The Hall of Justice VUK
6. The Deadworld orbit thingy
7. The crane
8. The playfield

MPF keeps track of how many balls are in each ball device at all times, and it knows which devices are in the process of ejecting (and which target devices they're ejecting to), so it also knows if balls get stuck along the way.

Ball devices support all sorts of settings and events. You can also configure counting delays to account for balls bouncing around before they settle, you can specify how devices confirm that balls have successfully ejected, as well as dozens of other options that allow MPF to support every known type of device in every pinball machine ever created. (Seriously.)

Monitorable Properties

For *dynamic values* and *conditional events*, the prefix for ball devices is `device.ball_devices.<name>`.

available_balls Number of balls that are available to be ejected. This differs from *balls* since it's possible that this device could have balls that are being used for some other eject, and thus not available.

state What state this device is in.

balls How many balls this device is currently holding.

Related How To guides

- *How to configure a modern trough with opto switches*
- *How to configure a modern trough with mechanical switches*
- *How to configure an older style trough with two coils and switches for each ball*
- *How to configure an older style trough with two coils and only one ball switch*
- *How to configure a classic single-ball trough*

Related Events

- *balldevice_ball_missing*
- *balldevice_balls_available*
- *balldevice_(balls)_ball_missing.*
- *balldevice_captured_from_(device)*
- *balldevice_(name)_ball_eject_attempt*
- *balldevice_(name)_ball_eject_failed*
- *balldevice_(name)_ball_eject_success*
- *balldevice_(name)_ejecting_ball*

Coils (Solenoids)

Related Config File Sections

coils:

coil_player:

In MPF, you typically list all the coils in your machine in the [coils: section](#) of your machine configuration file, along with default options for them, like pulse times, PWM values, whether they can be enabled (held on), etc.

You don't typically work with coils directly, rather, you tend to add them to other devices once they've been defined (flippers, autofires, ball devices, diverters, etc.)

That said, it is possible to perform actions on coils directly, such as pulsing, enabling, or disabling them. You can do this via the [coil_player:](#) section of a config file or via the [coils:](#) section of a [show](#).

Related How To Guides

Tutorial step 3: Get flipping!
--

Related Events

None

Adjust coil strength (pulse times)

Modern pinball controller systems that MPF use have the ability to precisely control how long (in milliseconds) the full power is applied to a coil. (Longer time = more power.) This is called the “pulse time” of a coil, as it controls how long the coil is pulsed MPF sends the coil a pulse command.

You can adjust this setting for all the coils in your machine, including flippers, trough ejects, pop bumpers, etc.

This is much nicer than the old days (even the 1990s WPC era) where pulse times were fixed, and you adjusted the strength of a mechanism by literally swapping out the coil with a stronger or weaker one!

Note: If you have “[dual wound](#)” coils, which are common for flippers, diverters, and other mechs which are “held” in the on position, you can use the pulse settings defined in this guide to control the initial “pulse” portion of that coil's activation.

Adjusting the pulse time is a bit of an art. If the pulse time is too long, you'll risk breaking something and the ball will fly off the mechanism too fast. Times that are too low will make the machine seem sluggish.

We suggest that you start with a slow time and slowly increase it until it feels right.

Unfortunately there's no universal pulse time setting that will work on every machine since the “pulse time” to “actual strength” mapping varies depending on:

- What type of coils you have (wire gauge and number of windings).
- How much voltage your power supply provides.

- How much current is available.
- How clean or worn your mechanisms, return springs, and/or coil sleeves are.
- How warm your coils are.

Pulse values can vary widely. One of our machines using new Williams flipper mechanisms with a 70vdc power supply has flipper pulse times of 14ms. Our 1974 Gottlieb Big Shot machine using the original flipper mechs has a pulse time over 100ms.

You adjust the pulse time for each coil by adding a `pulse_ms` setting to the coil's entry in the `coils` section of your machine config file. (Notice that you make this change in the `coils` section of your config, not the section for the individual mech that coil is part of.)

If you don't specify a time for a particular coil, then MPF will a default pulse time of 10ms. (10ms is almost certainly too low, but it's a very safe default starting point.)

For example, for coils used in dual-wound flippers:

```
coils:
  c_flipper_left_main:
    number: 00
    pulse_ms: 20
  c_flipper_left_hold:
    number: 01
    allow_enable: true
  c_flipper_right_main:
    number: 02
    pulse_ms: 20
  c_flipper_right_hold:
    number: 03
    allow_enable: true
```

Or for single-wound flipper coils:

```
coils:
  c_flipper_left:
    number: 0
    allow_enable: true
    hold_power: 1
    pulse_ms: 20
  c_flipper_right:
    number: 1
    allow_enable: true
    hold_power: 1
    pulse_ms: 20
```

Again, you just need to play your game and see how it feels. Then keep on adjusting the `pulse_ms` values up or down until your flippers feel right.

You might find that you have to adjust this `pulse_ms` setting down the road too. If you have a blank playfield then you might think that your coils are fine where they are, but once you add some ramps you might realize it's too hard to make a ramp shot and you have to increase the power a bit. Later on when you have a real game, you can even expose these pulse settings to operators via the service menu.

Advanced settings vary based on hardware

In addition to being able to specify how long a coil is pulsed for, some pinball control systems allow you to control the power that's applied to the coil during the initial pulse. (So instead of 100% power for 50ms, you might be able to set a coil to 75% power for 60ms.)

See the [hardware documentation for your platform](#) for links to specific coil settings your hardware might allow.

Adjust coil hold power

In MPF, a coil is said to be “held” (or “enabled”) any time it's activated for more than 255ms.

Most coils are only used in the “pulse” mode (slingshots, pop bumpers, trough and ball device ejects, etc.).

However, some pinball devices need to hold a coil on for longer (flippers, diverters, some older types of trough ball releases, etc.).

In MPF, you can adjust the power that's applied when these coils are held on past their initial pulse point.

Single-wound versus dual-wound coil holds

The way you configure coil holds depends on whether the coil in question is a “single wound” or “dual wound” coil. See the [Dual-Wound versus Single-Wound coils](#) guide for details.

Adjusting single-wound coil “hold” strength

Coils in MPF have a `hold_power`: setting which is used to control the amount of power that's applied to the coil after the initial pulse time.

The `hold_power` setting is a value from 0-8, with 0 being 0% power (off), and 8 being 100% power. (So 4 = 50% power, 6 = 75%, etc.)

Consider the following example:

```
coils:
  some_coil:
    number:
    pulse_ms: 30
    hold_power: 2
```

In the example from a machine config file, the if the coil called `some_coil` is enabled (turned on) then that coil will receive full (100%) power for 30ms, and then after 30ms, the power drops down to 25%. The power will stay at 25% until the coil is turned off.

Note that the pinball control hardware cannot vary the voltage or current applied to a coil, rather it simulates lower power by rapidly pulsing the power. The example of `hold_power: 2` would equate to 25% power, which would mean the coil would get full power for 1ms, then it would get no power for 3ms, then full power for 1ms, etc.

The `hold_power`: setting is valid with every type of pinball control system that MPF supports. However, some control systems have additional options which you can use to fine-tune how the hold power is applied to a coil.

See the [hardware documentation for your platform](#) for links to specific coil settings your hardware might allow.

The big question is what `hold_power`: setting is appropriate for your scenario? Unfortunately we don't have any good guidance for what your `hold_power`: values should be. Really you can just start with a value of 1 or 2 and then keep increasing it (whole numbers only) until your holds are strong enough not to break their hold when a ball hits them.

Adjusting dual-wound coil “hold” strength

If you have dual-wound coils then, the hold winding is designed to be held on, for long periods of time so you can safely keep it on full strength solid and don't have to mess with `hold_power`: settings.

The important caveat there is that the hold windings are designed around certain voltages. So if you have a dual-wound coil from a Stern machine that was designed to run at 48v, and you're using it in a new machine that's running at 70v, you'd probably want to use a `hold_power`: setting that's lower.

Again, you'll need to play with the settings to see what makes sense, and always choose the lowest one that works since if you have a setting that's too high, you probably won't know it until it's too late and the coil has burned up.

Recycle / “Cool Down” Time

TODO

Diverters

Related Config File Sections

<i>diverters</i> :

- *[Monitorable Properties](#)*
- *[Related How To guides](#)*
- *[Related Events](#)*

In MPF, a diverter (sometimes spelled “divertor”) is anything that alters the path of the ball based on the state it's in, including:

- A traditional diverter which is a metal flap at the end of a rod, typically used on ramps to “divert” the ball one way or the other.
- A coil-controlled post that pops up (or down) to let the ball either pass over it or bounce back in some other direction. (This is sometimes called an “up/down” post.)
- A coil-controlled gate, typically which only allows the ball to flow through it in a single direction, but lifted out of the way via a coil when active which allows the ball to travel through it in both directions.
- A “trap door” pop-up which captures the ball when it's up but lets the ball roll over it to another shot when it's down. (Like the trap door / basement in Theatre of Magic.)

- A single drop target that blocks the entrance to a shot when it's up, such as in the back of the saucer in Attack from Mars or the ones that block the ramps in Ghostbusters.
- Something else completely custom, such as the Ringmaster in Circus Voltaire. (When it's up the ball can hit it and drop down under the playfield, and when it's down the ball rolls over it and hits standup targets behind it.)

At this point you might be thinking, "Wait, you consider a trap door or the Ringmaster to be a diverter?? What???" But if you think about it from the perspective of pinball software, yeah, trap doors and the Ringmaster are diverters because when they are not active, a ball shot to them goes towards one place, and when they're active, a ball is "diverted" to go somewhere else.

Note: MPF's diverters are integrated with *Ball Devices* and MPF's ball management and routing system so they can be used to ensure that MPF is able to move balls to where they need to be.

Most diverters are held in their "on" position as long as their driver coil enabled, and then when they're disabled they return back to their off position. That said, some are different. The Ringmaster has a motor which raises and lowers it, and drop targets have coils that are just pulsed to raise/lower them, so this is not a hard and fast rule.

So based on all that, let's look at how the MPF actually handles diverters. At the most basic level, most diverters are just a coil, so fundamentally we don't really need to do anything special to control a diverter. As a game programmer you just need to enable a coil. But if you want to program your game code to control a diverter, there's a lot of glue you need to fully integrate it into your machine, and that's the glue that we've pre-written into our diverter device code.

For example, many diverters attached to ramps do not hold their coils in the "on" position for the entire time that they're on. Instead they use the ramp entry switch to see when a ball is coming their way, and when one is they quickly activate so they can catch the ball in time to divert it. They also typically have a timeout where they deactivate themselves if they don't actually see a ball get diverted, (like with a weak ramp shot that trips the ramp entry switch but that isn't powerful enough to make it all the way up the ramp to the diverter.)

MPF's diverter devices also include support for automatic enabling and disabling (based on events), and they include intelligence to know which target devices a diverter will send a ball to when it's enabled or disabled.

Monitorable Properties

For *dynamic values* and *conditional events*, the prefix for diverters is `device.diverters.<name>`.

active Boolean (true/false) as to whether this diverter is actively on and in the powered state.

enabled Boolean (true/false) as to whether this diverter is enabled (meaning it will be activated when a ball approaches it).

eject_state Boolean (true/false) which shows whether this diverter will be activating to route a ball eject from an upstream ball device.

Related How To guides

Todo: TODO

Related Events

- *diverter_(name)_activating*
- *diverter_(name)_deactivating*
- *diverter_(name)_disabling*
- *diverter_(name)_enabling*

Drop Targets

Related Config File Sections
<i>drop_targets:</i>
<i>drop_target_banks:</i>

- *Monitorable Properties*
 - *Related How To guides*
 - *Related Events*

Mission Pinball Framework's (MPF) *drop target* device represents a switch in a pinball machine. This device is used for drop target banks with a coil for resetting.

Monitorable Properties

For *dynamic values* and *conditional events*, the prefix for drop targets is `device.drop_targets.<name>`.

complete Boolean (true/false) which shows whether this drop target is complete (down).

Related How To guides

Todo: TODO

Related Events

- *drop_target_(name)_down*
- *drop_target_(name)_up*

Drop Target Bank

Related Config File Sections

<i>drop_target_banks:</i>

- [*Monitorable Properties*](#)
- [*Related How To guides*](#)
- [*Related Events*](#)

In MPF, you can combine multiple drop targets into drop target banks. The main reasons for doing this are to combine reset coils (since one coil typically resets an entire bank) and to get additional events posted when the entire bank is up, down or in a mixed state.

Monitorable Properties

For [*dynamic values*](#) and [*conditional events*](#), the prefix for drop target banks is `device.drop_target_banks.<name>`.

complete Boolean (true/false) which shows whether every target in this bank is complete (down).

down Number of drop targets in the bank that are in the down state.

up Number of drop targets in the bank that are in the up state.

Related How To guides

Todo: TODO

Related Events

- [*drop_target_bank_\(name\)_down*](#)
- [*drop_target_bank_\(name\)_up*](#)
- [*drop_target_bank_\(name\)_mixed*](#)

Dual-wound Coils

Related Config File Sections

<i>dual_wound_coils:</i>
--

A *dual-wound coil* is a coil (solenoid) with two windings—one “strong” power (or “main”) winding for moving the coil, and a second weaker / lower-power winding for “holding” the coil in the active position.

Dual-wound coils are typically used for flippers, diverters, gates, and other devices in pinball machines that need a strong initial movement followed by an extended hold period.

There are many places in MPF config files where you need to specify a coil name. Rather than adding dual-wound coil logic in many different sections of MPF, we have a dual-wound coil config where you can specify the settings for a particular dual-wound coil (and give it a new name), and then you can use that dual-wound coil anywhere in MPF that a coil is configured.

Related How To Guides
TODO

Related Events
None

Dual-Wound versus Single-Wound coils

It's common for pinball machines to include coils that are "held on" for periods of time longer than the maximum pulse time of 255ms. The obvious example of this is for flipper coils, though other types of devices use these too. (Diverters, the trolls in *Medieval Madness*, certain ball release coils, etc.)

In many cases, these types of coils need to have strong initial pulses to quickly move the mechanism from its resting to active position, but they also need to be able to be held "on" for a long period of time.

These two requirements are conceptually incompatible.

The way you make a coil strong is you give it lots of power and make it really big. Unfortunately the byproduct of that is heat, which means if you make a nice, big, powerful coil that's strong enough to move the mechanism with the quick power it needs, then when the coil is left in the "on" state, it generates so much heat that it will burn up the coil. :(

Fortunately the pinball companies solved this 60+ years ago with the concept of "dual wound" coils. A dual-wound coil is essentially two separate coils in one. (There are literally two separate wires wrapped around the coil sleeve instead of one.)

Dual-wound coils have a strong (often called the "main" or "power") winding which is used for the initial "kick" of the coil, and they also have a lower-powered ("hold") winding which is used to hold the active position.

Note: You can tell if a coil is dual-wound because the coil will have three wire connection points instead of two. There's a power winding connector, a hold winding connector, and a common connector that's shared by both.

The way these are used is that the strong winding is pulsed initially (usually for a fraction of a second) to provide the initial strength to move the mechanism, then it cuts off, leaving just the weaker hold winding active to keep the mechanism active. The hold winding can safely be enabled for a long time, even multiple minutes. When the machine wants to disable the device (or when the player releases the flipper button in the case of a flipper), the power to the hold winding is cut, and a spring causes the mechanism to return to the initial position.

Transitioning from the power to the hold winding: The old way

In old pinball machines (from the 1940s through the early 2000s), the “transition” from the power winding to the hold winding was purely mechanical and done using something called an “end of stroke” (EOS) switch.

The EOS switch is a physical leaf switch in the mechanism under the playfield with a switch that is mechanically opened by the movement of the device. When the coil is first activated, the current flows to both the power and the hold windings, and the mech starts to move. A few fractions of a second later, the mech reaches its full “up” position, and a little arm under it hits the EOS switch which opens it and breaks the connection to the power winding, leaving only the hold winding energized.

When the hold winding is de-energized, the spring causes the mechanism to move back to the original position, and the EOS switch is closed (by the movement of the mech) meaning that the next time the mech is activated, the current will again flow to both the power and hold windings.

Advantages of using this “old style” EOS switch

- It’s simple. No computers or fancy timing has to be involved, and the transition from the power to the hold windings is automatic.
- If a coil gets dirty, gummed up, or weak, the transition from the power to the hold winding always occurs only after the mech is all the way in the “active” position.
- Only a single “driver” connection from the control system is needed since that single control line is used for both the power and hold windings.

Downsides to using this “old style” EOS switch

- No fine tuning. Since the transition from the power to the hold winding is purely mechanical, you can’t change the power of the mechanism unless you physically switch out the coil and/or change the voltage used.
- For flippers, you don’t get any “novelty” flipper modes. You can’t do things like “weak flippers” or “no hold flippers” since the flipper behavior is mechanically controlled.

Transitioning from the power to the hold winding: The modern way

Modern machines do not use EOS switches in the same way they have been used in older machines.

The main reason for this is that modern pinball control systems (including all the *control systems* that MPF supports) have the ability to activate coils with millisecond-level precision (something that was not possible even in 1990s WPC machines).

Using flippers as an example, in modern machines, when the player presses the flipper button, the control system will send current to both the power and hold windings at the same time, and then at a very precise moment (e.g. 27ms later or 14ms later or whatever), the control system will cut off the power winding, leaving just the hold winding active.

This has the same effect of the mechanical EOS switch in that the power winding is only used for the initial power motion, and the lower-current hold winding is then used to keep the flipper in the up position.

Advantages of using the modern transition from power to hold

- You can fine-tune coil strength by changing settings in software.
- You can use novelty modes like weak flippers, no hold flippers, etc.

Downsides of using the modern transition from power to hold

- You have to play with your settings to get them right.
- A dirty, gummed up, or worn-out coil or mechanism might mean that the initial power timing setting you originally configured might not be strong enough to move the mechanism all the way into the “up” position.

Single-wound coils

So far both options (EOS and non-EOS) we discussed use dual-wound coils with power and hold windings.

However there’s a third option that some modern machines use as well. The third option is to use more traditional (e.g. “single wound”) coils for your machine that do not have the dual “power” and “hold” windings.

Of course you might be thinking, “How does that work? Wouldn’t the coil burn up if the mechanism was active for too long?”

This is another case where modern technology can be used to address that.

In electronics, there’s a concept called “Pulse Width Modulation” (or “PWM”), which (in this case) basically means the control hardware turns the power on and off really fast. (Like, hundreds of times per second.)

So the way this works is that you have a high-powered, strong coil which is activated a full strength in order to provide the strong initial motion. However once the mechanism is in the up position (based on either an EOS switch, or based on the millisecond-level precise timing), the control system stops powering that coil at 100% and instead cuts the power back (using that PWM thing) to a smaller percent (like maybe 12.5% or 25% or so). That reduced power is enough to keep the mech in the up position, but not enough to cause the coil to overheat and burn out.

Advantages to using single-wound coils

- You only need a single driver output per coil (instead of two).
- You can still do the modern things, like use software to tune the strength of the coil and novelty flipper modes.

Downsides to using single-wound coils

- You have to figure out the PWM (low power) settings which need to be strong enough to hold the mechanism up but not too strong so they don’t burn it up.
- Sometimes the PWM “hold” makes an annoying buzzing sound (since the power is being turned on and off hundreds of times per second).

We should note that the decision to use a single-wound versus dual-wound flipper coil is technically a separate decision from whether or not to use an EOS switch. See the [Flipper end-of-stroke \(EOS\) switches](#) for more on that decision.

Which option should you choose?

Ok, so basically there are three options for coils that need to be held on for more than 255ms:

- Dual-wound, with a mechanical EOS switch to transition from power to hold.
- Dual-wound, with the control system timing to transition from power to hold.
- Single-wound

The good news is that MPF supports all three options.

If you're retheming an existing machine, and you're using the original driver boards and power supplies, then you should probably just use whatever method was used in that machine and keep it simple.

If you're building a new machine, most people choose the second option, where you use a dual-wound coil but with the transition of the power to hold windings done via software and the modern control systems. The reasons for this include:

- It's simple. You don't have to mess with trying to figure out the PWM timings for the hold winding.
- It works. You know the hold winding was designed to be held on at full power, so you don't have to worry about breaking things.
- It's less wear-and-tear and emissions. Rapidly cycling power (in the PWM way) for the hold phase in a single-wound coil has the potential to add wear to the components in your system and potential to cause EMI emissions.

People have also pointed out that Stern's S.A.M. system (which they used in from about 2006-2015) used the single-wound PWM-style flippers, but then with the SPIKE system (from 2015 onwards) went back to the dual-wound computer controlled option. So even in this modern era, there's precedent for using dual-wound coils.

Really the only reasons to use the single-wound coils are:

- You already have mechanisms that use single-wound coils
- You're running out of driver outputs in your control system and you don't want to "waste" two drivers per mech.

Flashers

Related Config File Sections
flashers:
flasher_player:

MPF includes support for flashers, which are essentially just really bright lights that are controlled via high-power driver transistors instead of low-power lighting circuitry.

MPF's flasher devices are only used in older machines (WPC, Stern SAM, System 11) since modern LED-based machines typically use regular LED devices (or combinations of them) as flashers. (So basically a “flasher” in MPF is any single-color light that's connected to a driver output rather than a light output.)

Related How To Guides
TODO

Related Events
None

Flippers

Related Config File Sections
<i>flippers:</i>

- [Monitorable Properties](#)
- [Related How To guides](#)
- [Related Events](#)

Flippers are probably the first thing you think of when you think about building your own pinball machine. In fact when most people get their own hardware and start drilling holes in a piece of plywood, the first visible thing they do is to get their flippers flipping.

MPF has support for lots of different kinds of flippers (as there are many different ways they've been wired over the years), as well as a lot of different options for how flippers are fine tuned.

MPF also has support for various “novelty” flipper modes (no-hold flippers, reversed flipper buttons, weak flippers, etc.)

We recommend you read the [Dual-Wound versus Single-Wound coils](#) guide to understand the difference between “dual wound” and “single wound” coils, as flippers in pinball machines can be either type.

You should also probably read the EOS Switches guide if your machine has flipper EOS switches. (In general EOS switches are not needed for flippers with MPF.)

Monitorable Properties

For [dynamic values](#) and [conditional events](#), the prefix for flippers is `device.flippers.<name>`.

enabled Boolean (true/false) which shows whether this ball hold is enabled.

Related How To guides

How to configure dual-wound flippers

This guide shows you how to configure dual-wound flippers in MPF. If you don't know what "dual-wound" flippers are, or whether you have them, take a look at the coil that your flipper uses. If it has three wires (or three tabs to connect three wires), then it's a dual-wound coil and this guide is for you.

If it has two wires (or two tabs), then read the [How to configure single-wound flippers](#) guide.

Read more about "dual wound" versus "single wound" coils in the [Dual-Wound versus Single-Wound coils](#) guide.

1. Add your flipper buttons

First, make sure you have entries in your machine config for your flipper buttons.

Here's an example config.yaml with two switches added:

```
#config_version=4

switches:
  s_left_flipper:
    number: 1
    tags: left_flipper
  s_right_flipper:
    number: 2
    tags: right_flipper
```

You can pick whatever names you want for your switches. We chose s_left_flipper and s_right_flipper.

Note that we configured this switches with numbers 1 and 2, but you should use the actual switch numbers for your control system that the flipper buttons are connected to. (See [How to configure "number:" settings](#) for instructions for each type of control system.)

We also added tags called left_flipper and right_flipper. These are optional, but recommended. The reason is that MPF includes a [combo switch](#) feature which posts events when player switches are held in combination. If you add these tags to your flipper switches, an event called *flipper_cancel* will be posted when the player hits both flipper buttons at the same time which you can use to cancel shows and other things you want the player to be able to skip.

2. Add your flipper coils

Next you need to add entries for your flipper coils to your machine-wide config. These will be added to a section called coils:. Since we're using dual-wound coils, there will actually be two coil entries for each coil—one for the power (main) winding, and one for the hold winding.

```
coils:
  c_flipper_left_main:
    number: 0
  c_flipper_left_hold:
    number: 1
```



```
    allow_enable: true
c_flipper_right_main:
    number: 2
c_flipper_right_hold:
    number: 3
    allow_enable: true
```

Again, the `number:` entries in your config will vary depending on your actual hardware, and again, you can pick whatever names you want for your coils.

Also note that the two hold coils have `allow_enable: true` entries added. (In MPF config files, values of “yes” and “true” are the same.) The purpose of the `allow_enable: true` setting is that as a safety precaution, MPF does not allow you to enable (that is, to hold a coil in its “on” position) unless you specifically add `allow_enable: true` to that coil’s config.

So in the case if your flippers, the hold coil of a flipper needs to have `allow_enable: true` since in order for it to act as a flipper, that coil needs to be allowed to be enabled (held on).

3. Add your flipper entries

At this point you have your coils and switches defined, but you can’t flip yet because you don’t have any flippers defined. Now you might be thinking, “Wait, but didn’t I just configure the coils and switches?” Yes, you did, but now you have to tell MPF that you want to create a flipper mechanism which links together the switch and the coils to become a “flipper”.

You create your flipper mechanisms by adding a `flippers:` section to your machine config, and then specifying the switch and coils for each flipper that you defined in Steps 1 and 2.

Here’s what you would create based on the switches and coils we’ve defined so far:

```
flippers:
  left_flipper:
    main_coil: c_flipper_left_main
    hold_coil: c_flipper_left_hold
    activation_switch: s_left_flipper
  right_flipper:
    main_coil: c_flipper_right_main
    hold_coil: c_flipper_right_hold
    activation_switch: s_right_flipper
```

4. Enabling your flippers

By default, MPF only enables flippers when a game is in progress. So if this is a first-time config and you haven’t configured your ball devices and start button and everything, you can’t actually start a game yet, which means you can’t test your flippers.

Fortunately we can get around that by configuring your flippers to just automatically enable themselves when MPF starts. To do this, add the following entry to each of your flippers in your config file:

```
enable_events: machine_reset_phase_3
```

So now the `flippers:` section of your config file should look like this:


```
flippers:
  left_flipper:
    main_coil: c_flipper_left_main
    hold_coil: c_flipper_left_hold
    activation_switch: s_left_flipper
    enable_events: machine_reset_phase_3
  right_flipper:
    main_coil: c_flipper_right_main
    hold_coil: c_flipper_right_hold
    activation_switch: s_right_flipper
    enable_events: machine_reset_phase_3
```

5. Configure your control system hardware

At this point your flipper configuration is technically complete, though there are two other important things you may have to do first:

If you're using physical hardware, you may need an additional section in your machine config for your control system. (For example, FAST Pinball and Open Pinball Project controllers require a one-time port configuration, etc.) See the [control system documentation](#) for details.

6. Adjust your flipper power

As a safety precaution, MPF uses very low (10ms) default pulse times for coils. In most cases, 10ms will not be enough power to physically move the flippers when you hit the button. (You might hear them click or buzz without actually seeing them move.)

So check out the documentation in the coils section for instructions on how to adjust the [pulse power](#) and the [hold power](#) for the coils you're using for your flippers.

Here's the complete config

Here's the complete machine config file (or sections of the machine config file) we created in this How To guide:

Listing 7.1: `/config/config.yaml`

```
#config_version=4

hardware:
  platform: fast
  driverboards: fast

switches:
  s_left_flipper:
    number: 0-0
    tags: left_flipper
  s_right_flipper:
    number: 0-1
    tags: right_flipper
```



```
coils:
  c_flipper_left_main:
    number: 0-0
    pulse_ms: 30
  c_flipper_left_hold:
    number: 0-1
    allow_enable: true
  c_flipper_right_main:
    number: 0-2
    pulse_ms: 30
  c_flipper_right_hold:
    number: 0-3
    allow_enable: true

flippers:
  left_flipper:
    main_coil: c_flipper_left_main
    hold_coil: c_flipper_left_hold
    activation_switch: s_left_flipper
    enable_events: machine_reset_phase_3
  right_flipper:
    main_coil: c_flipper_right_main
    hold_coil: c_flipper_right_hold
    activation_switch: s_right_flipper
    enable_events: machine_reset_phase_3
```

How to configure single-wound flippers

This guide shows you how to configure single-wound flippers in MPF. If you don't know what "single-wound" flippers are, or whether you have them, take a look at the coil that your flipper uses. If it has two wires (or two tabs to connect two wires), then it's a single-wound coil and this guide is for you.

If it has three wires (or three tabs), then read the [How to configure dual-wound flippers](#) guide.

Read more about "dual wound" versus "single wound" coils in the [Dual-Wound versus Single-Wound coils](#) guide.

1. Add your flipper buttons

First, make sure you have entries in your machine config for your flipper buttons.

Here's an example config.yaml with two switches added:

```
#config_version=4

switches:
  s_left_flipper:
    number: 1
    tags: left_flipper
  s_right_flipper:
    number: 2
    tags: right_flipper
```


You can pick whatever names you want for your switches. We chose `s_left_flipper` and `s_right_flipper`.

Note that we configured these switches with numbers 1 and 2, but you should use the actual switch numbers for your control system that the flipper buttons are connected to. (See [How to configure “number:” settings](#) for instructions for each type of control system.)

We also added tags called `left_flipper` and `right_flipper`. These are optional, but recommended. The reason is that MPF includes a [combo switch](#) feature which posts events when player switches are held in combination. If you add these tags to your flipper switches, an event called `flipper_cancel` will be posted when the player hits both flipper buttons at the same time which you can use to cancel shows and other things you want the player to be able to skip.

2. Add your flipper coils

Next you need to add entries for your flipper coils to your machine-wide config. These will be added to a section called `coils:`.

```
coils:
  c_flipper_left:
    number: 0
    allow_enable: true
    hold_power: 1
  c_flipper_right:
    number: 1
    allow_enable: true
    hold_power: 1
```

Again, the `number:` entries in your config will vary depending on your actual hardware, and again, you can pick whatever names you want for your coils.

Also note that the coils have `allow_enable: true` entries added. (In MPF config files, values of “yes” and “true” are the same.) The purpose of the `allow_enable: true` setting is that as a safety precaution, MPF does not allow you to enable (that is, to hold a coil in its “on” position) unless you specifically add `allow_enable: true` to that coil’s config.

Since flippers need to be held on (as long as the flipper button is active), you need `allow_enable: true` in the coil config for them.

Finally, notice that there’s a `hold_power: 1` setting for each coil. That is the power value (from 0-8) which controls how much power is applied to the flipper when it’s held on. A value of 1 is 1/8th power, (12.5%), a value of 2 is 2/8 which is 1/4 which is 25%, a value of 3 is 37.5%, 4 is 50%, etc.

We just start with the lowest setting for now and you can increase it later if it’s not enough.

3. Add your flipper entries

At this point you have your coils and switches defined, but you can’t flip yet because you don’t have any flippers defined. Now you might be thinking, “Wait, but didn’t I just configure the coils and switches?” Yes, you did, but now you have to tell MPF that you want to create a flipper mechanism which links together the switch and the coils to become a “flipper”.

You create your flipper mechanisms by adding a `flippers:` section to your machine config, and then specifying the switch and coils for each flipper that you defined in Steps 1 and 2.

Here's what you would create based on the switches and coils we've defined so far:

```
flippers:
  left_flipper:
    main_coil: c_flipper_left
    activation_switch: s_left_flipper
  right_flipper:
    main_coil: c_flipper_right
    activation_switch: s_right_flipper
```

4. Enabling your flippers

By default, MPF only enables flippers when a game is in progress. So if this is a first-time config and you haven't configured your ball devices and start button and everything, you can't actually start a game yet, which means you can't test your flippers.

Fortunately we can get around that by configuring your flippers to just automatically enable themselves when MPF starts. To do this, add the following entry to each of your flippers in your config file:

```
enable_events: machine_reset_phase_3
```

So now the flippers: section of your config file should look like this:

```
flippers:
  left_flipper:
    main_coil: c_flipper_left
    activation_switch: s_left_flipper
    enable_events: machine_reset_phase_3
  right_flipper:
    main_coil: c_flipper_right
    activation_switch: s_right_flipper
    enable_events: machine_reset_phase_3
```

5. Configure your control system hardware

At this point your flipper configuration is technically complete, though there are two other important things you may have to do first:

If you're using physical hardware, you may need an additional section in your machine config for your control system. (For example, FAST Pinball and Open Pinball Project controllers require a one-time port configuration, etc.) See the [control system documentation](#) for details.

6. Adjust your flipper power

As a safety precaution, MPF uses very low (10ms) default pulse times for coils. In most cases, 10ms will not be enough power to physically move the flippers when you hit the button. (You might hear them click or buzz without actually seeing them move.)

So check out the documentation in the coils section for instructions on how to adjust the *pulse power* and the *hold power* for the coils you're using for your flippers.

Here's the complete config

Here's the complete machine config file (or sections of the machine config file) we created in this How To guide:

```
#config_version=4

switches:
  s_left_flipper:
    number: 1
    tags: left_flipper
  s_right_flipper:
    number: 2
    tags: right_flipper

coils:
  c_flipper_left:
    number: 0
    allow_enable: true
    hold_power: 1
  c_flipper_right:
    number: 1
    allow_enable: true
    hold_power: 1

flippers:
  left_flipper:
    main_coil: c_flipper_left
    activation_switch: s_left_flipper
    enable_events: machine_reset_phase_3
  right_flipper:
    main_coil: c_flipper_right
    activation_switch: s_right_flipper
    enable_events: machine_reset_phase_3
```

How to configure multiple flippers

TODO

Multiple flippers with a single switch

Multiple flippers with two-stage switches

How to enable “secondary playfield” flippers

TODO

How to temporarily disable flippers

TODO


```
#config_version=4

flippers:
  flipper_left_front:
    main_coil: c_flipper_left_front
    activation_switch: s_flipper_left_front
    hold_coil:
    enable_events: ball_started, flipper_on, flippers_front_on
    disable_events: ball_will_end, flipper_off, flippers_front_off
  flipper_right_front:
    main_coil: c_flipper_right_front
    activation_switch: s_flipper_right_front
    hold_coil:
    enable_events: ball_started, flipper_on, flippers_front_on
    disable_events: ball_will_end, flipper_off, flippers_front_off
  flipper_left_back:
    main_coil: c_flipper_left_back
    activation_switch: s_flipper_left_back
    hold_coil:
    enable_events: ball_started, flipper_on, flippers_back_on
    disable_events: ball_will_end, flipper_off, flippers_back_off
  flipper_right_back:
    main_coil: c_flipper_right_back
    activation_switch: s_flipper_right_back
    hold_coil:
    enable_events: ball_started, flipper_on, flippers_back_on
    disable_events: ball_will_end, flipper_off, flippers_back_off
```

```
#config_version=4

mode:
  start_events: ball_starting, one_on_one_started
  stop_events: ball_ending, one_on_one_start
  priority: 1000

event_player:
  mode_punishment_started: flippers_on
  timer_flippers_disabled_front_started: flippers_front_off
  timer_flippers_disabled_front_complete: flippers_front_on
  timer_flippers_disabled_back_started: flippers_back_off
  timer_flippers_disabled_back_complete: flippers_back_on

#show_player:
#   timer_flippers_button_active_left_front_tick{ticks==5}:
#       flash_red:
#           speed: 2
#           leds: playfield_front
#           key: front_left
#   timer_flippers_button_active_left_front_stopped:
#       front_left: stop

timers:
  flippers_button_active_left_front:
    control_events:
      - event: s_flipper_left_front_active
```



```

        action: restart
        - event: s_flipper_left_front_inactive
        action: stop
    start_value: 0
    end_value: 10
    direction: up
    tick_interval: 1s
flippers_button_active_right_front:
    control_events:
        - event: s_flipper_right_front_active
        action: restart
        - event: s_flipper_right_front_inactive
        action: stop
    start_value: 0
    end_value: 10
    direction: up
    tick_interval: 1s

flippers_button_active_left_back:
    control_events:
        - event: s_flipper_left_back_active
        action: restart
        - event: s_flipper_left_back_inactive
        action: stop
    start_value: 0
    end_value: 10
    direction: up
    tick_interval: 1s
flippers_button_active_right_back:
    control_events:
        - event: s_flipper_right_back_active
        action: restart
        - event: s_flipper_right_back_inactive
        action: stop
    start_value: 0
    end_value: 10
    direction: up
    tick_interval: 1s

flippers_disabled_front:
    control_events:
        - event: timer_flippers_button_active_left_front_complete
        action: start
        - event: timer_flippers_button_active_right_front_complete
        action: start
        - event: timer_flippers_disabled_front_complete
        action: reset
    start_value: 0
    end_value: 3
    direction: up
    tick_interval: 1s
flippers_disabled_back:
    control_events:
        - event: timer_flippers_button_active_left_back_complete
        action: start

```



```
- event: timer_flippers_button_active_right_back_complete
  action: start
- event: timer_flippers_disabled_back_complete
  action: reset
start_value: 0
end_value: 3
direction: up
tick_interval: 1s
```

How to enable “reversed flippers” (novelty mode)

TODO

How to enable “no hold flippers” (novelty mode)

TODO

How to enable “weak flippers” (novelty mode)

TODO

How to enable “inverted flippers” (novelty mode)

TODO

How to enable “delayed flippers” (novelty mode)

TODO

Related Events

None

Flipper end-of-stroke (EOS) switches

Here’s the thing about EOS switches in a modern pinball machine: they’re optional.

To be very clear, EOS switches are only optional if the software is written to not use them. You can’t just walk up to an existing game and cut the wires to the EOS switches or you’ll probably burn up your coils. (I say “probably” because some games will detect that the EOS switch wasn’t hit when it should have been and cut the power anyway.)

If you wanted to program a game without EOS switches, you could do that. The way you’d do that is to flip from “power” to “hold” mode after a predefined time (like 30ms), rather than waiting for an EOS switch to be engaged.

Why would you want to use the “pulse timing” method versus the “EOS switch” method for the flipper power stroke? There are a few reasons:

- You can control the “strength” of the flippers in software, rather than with hardware. This means you can fine tuning the flipper feel for your game without having to swap coils or adjust voltages.
- You can allow operators to change flipper strength via a service menu item, compensating for mismatched coils, coil age, machine slope, etc.
- Your software can change the strength as part of a game feature. (For example, Wizard of Oz has a “weak flippers” mode which makes the shots harder.)

Having said this, there’s still a reason you might want to use the EOS switches today—the EOS switch can be used to detect if a fast-moving ball has hit the flipper so hard that it broke through the hold power and caused the flipper bat to fall down. The idea is you’d use the EOS switch to reactivate the power winding (or to reapply full power if you’re using the pulse method) until the EOS switch is activated again, and then you’d go back to holding the coil.

Whether you actually want to do this is a matter of opinion. Finding the proper strength for your hold power—especially if you’re using the pulse method—is a balance between applying enough power to keep the flipper bat up without using so much power that your coil overheats. Some argue that if you get this balance right, your hold power should be enough to stand up to a fast ball hitting an upheld flipper. The other thing to consider with this is that even if a fast-moving ball does knock the flipper bat down, there’s no agreement on whether automatically re-applying full power to raise the bat is the right thing to do. Some have argued that that’s confusing to the player, and that if the flipper bat does fall down when the player is not expecting it, that the player should choose to re-engage it by releasing and reapplying the flipper button.

Even if you don’t use EOS switches for action purposes in your game, chances are your flipper mechanisms have them. Assuming you have enough switch inputs available, we like the idea of wiring up your EOS switches anyway and just audit logging whether an EOS switch is deactivated while its associated flipper button is still active. Doing so means you capture the number of times a ball inadvertently moves a flipper bat, and you can make power adjustments to your hold phase accordingly. It also lets the machine know if the flippers are broken.

How does the machine know when the flipper is “up”?

You might notice that both of the options for not burning up the flipper coils when they’re held up require that the machine “knows” when the coil is up in order to switch over to hold mode. So how exactly does a machine know this?

Many flippers in pinball machines today have an “end of stroke” (or “EOS”) switch for each flipper. This switch was located under the playfield near the flipper coil, and it is physically activated by the flipper mechanism once it has rotated fully into the “up” position. In the old days (like in EM machines), the flipper coils all used the dual winding (i.e. “Option 1” from above) approach, and the EOS switch was a normally-closed switch connected in series with the flipper cabinet button which activated the power winding. So when the flipper button was pressed, both the power and hold windings were activated, and then when the flipper was all the way up it would open the EOS switch, cutting off power to the power winding. The hold winding remains energized until the player releases the flipper button.

When EOS switches are used in modern machines, they’re typically connected into the game like any other switch, so the CPU can process the EOS activation and disable the power winding or start pulsing the power.

Option 2: The flipper has one winding, and the game lowers the power once the flipper is up

The other type of flipper uses a normal coil with just a single winding. When the flipper button is pressed, the machine fires the flipper coil with normal full power. Then once the flipper makes it to the “up” position, the game starts pulsing the power really quickly. (So fast that it doesn’t move the flipper back down, but with enough “spaces” between the pulses that the coil doesn’t burn up.)

Then when the flipper button is released, the power is cut to the altogether. In case you’re wondering why the machine pulses the power, it’s because the pinball machine doesn’t have the ability to actually change the voltage and current that is supplied to the coil. That’s fine, though, because what actually causes a coil to burn is the heat generated from the current flowing through it. So a coil which is pulsed on then off every millisecond would only have a “duty cycle” of 50%, thereby generating far less heat and not burning up. (The 1ms on / 1ms off is just an example for this illustration. In a real machine it might be 1 on / 10 off, or 2/18, or 1/6—the exact pulse ratio depends on the coil type and the amount of voltage used.)

This single-winding coil is less common. Stern used to do it though in their current SPIKE system they’ve moved back to dual-wound flippers.

Design Decision 2: Pulse timings or EOS switch to indicate “up” position?

Next you have to figure out how you’re machine will know when to switch to the low power hold mode. (How it switches depends on Design Decision 1, where it either cuts off the high power winding, or switches over from the solid pulse to the quick on/off modulated pulses.) If you use pulse timings then it switches over after a certain number of milliseconds. If you use the EOS switch then it activates full power until the EOS switch is activated. Our view is that using the EOS switch to switch over to low-power hold mode is far less flexible than configuring specific initial pulse times. We like that this allows game designers and operators to precisely configure flipper power, and certainly this is a much more modern approach than physically swapping out flipper coils to increase or decrease power. Then again, if you’re old school and want to fire that flipper with full power until that EOS switch is activated, fine, go for it.

Design Decision 3: Will you use EOS switches to notify the game that a ball has “broken through” the hold?

Finally, you have to decide whether you’re going to use EOS switches to notify the machine when a flipper has lost its hold while the flipper button is still engaged. (And if so, what you’re going to do about it.) We believe the chances of a ball breaking the hold are generally slim, and if it’s something that happens often that indicates that your hold power is not strong enough. (Assuming you’re holding the flipper with the pulse modulation to the power winding rather than using a dual-wound coil.) We also believe that if a ball breaks a flipper hold, automatically reapplying full power to restore the hold can be confusing to the player. That said, all machines are different, and tastes are different, so you should go with whatever you want. The nice thing about not using EOS switches is again, you can free up those switch inputs for other things if you’re running low. But even if you don’t use them to automatically correct for a broken holds, we like the idea of still connecting the EOS switches and using them for audit logging purposes. (e.g. using them to record any instances of a flipper hold being broken by a fast moving ball, a broken hold winding, or a broken flipper.)

GI (general illumination)

Related Config File Sections
<i>gis:</i>
<i>gi_player:</i>

- *Monitorable Properties*
- *Related How To guides*
- *Related Events*

MPF includes support for GI (general illumination) light strings which are common in existing Williams and Stern machines. You can specify GI strings which you can then enable, disable, or (if the hardware supports it) dim.

Note: GI strings in the “gis:” config section are only for older existing machines that specifically have driver-powered GI strings. New custom machines will just use LEDs for GIs, and they are configured as LEDs, not GIs.

GI Strings are actually kind of complex. Many of them are AC (even in WPC machines), and some Williams WPC machines include triacs (kind of like a transistor for AC) and “zero cross” AC waveform detection circuits so they can sync their dimming commands with the AC current wave. Later Williams WPC machines split their GI into non-dimmable (which used still used AC) and switched their dimmable to DC. Some machines also have “enable” relays that must be activated first before certain GI strings will work.

MPF hides all this complexity from you. You just define your GI strings in your machine configuration file and then you can enable, disable, and dim the dimmable ones as you wish.

Monitorable Properties

For *dynamic values* and *conditional events*, the prefix for drop target banks is `device.drop_target_banks.<name>`.

brightness The numeric value of the brightness of this GI string, from 0-255.

Related How To guides

Todo: TODO

Related Events

None

Kickbacks

Related Config File Sections

<i>kickbacks:</i>

New in version 0.32.

- *Monitorable Properties*
- *Related How To guides*
- *Related Events*

A kickback mechanism is a type of *autofire coil* that kicks the ball back into play, typically located in an outlane.

Monitorable Properties

For *dynamic values* and *conditional events*, the prefix for kickbacks is `device.kickbacks.<name>`.

enabled Boolean (true/false) which shows whether this kickback is enabled.

Related How To guides

Todo: TODO

Related Events

- *kickback_(name)_fired*

Kicking Targets

Related Config File Sections

TODO

Mission Pinball Framework's (MPF) *kicking target* device represents a switch in a pinball machine. This device is used for kicking targets with a coil for kicking. Used rarely, these targets look like stationary targets, but when hit they kick the ball back in the opposite direction much like a slingshot or bumper.

Stationary Targets

Related Config File Sections
TODO

Mission Pinball Framework’s (MPF) *stationary target* device represents a switch in a pinball machine. This might also be know as a stand-up target. It is essentially a switch above the playfield with a scoring value associated with it. When the ball hits it the value is scored.

Vari Targets

Related Config File Sections
TODO

Mission Pinball Framework’s (MPF) *vari target* device represents a switch in a pinball machine. It is a metal arm that pivots under the playfield and awards a scoring value associated with it that changes depending on how hard the ball hits it. Typically the harder the ball hit the more points awarded.

Lights

Related Config File Sections
<i>matrix_lights:</i>
<i>matrix_light_settings:</i>
<i>light_player:</i>

- *Monitorable Properties*
- *Related How To guides*
- *Related Events*

Todo: TODO

Note that LEDs plugged into lamp matrices are configured here as lights, not in the `leds:` section. See “*Lights*” versus “*LEDs*” (Some LEDs are lights?!?) for details.

Monitorable Properties

For *dynamic values* and *conditional events*, the prefix for lights is `device.lights.<name>`.

brightness The numeric value of the brightness of this light, from 0-255.

Related How To guides

- [Tutorial step 17: Add lights \(or LEDs\)](#)

Related Events

None

LEDs

Related Config File Sections
<i>leds:</i>
<i>led_settings:</i>
<i>led_strips</i>
<i>led_rings</i>
<i>led_player:</i>

- [Monitorable Properties](#)
- [Related How To guides](#)
- [Related Events](#)

MPF can control LEDs, including single-channel (single color) and full RGB LEDs. (You can control the order too, so you can control RGB, BRG, etc.) You can set default fade rates and control strips and rings of LEDs.

Monitorable Properties

For *dynamic values* and *conditional events*, the prefix for LEDs is `device.leds.<name>`.

color

corrected_color

Related How To guides

Todo: TODO

Related Events

Related How To Guides
Tutorial step 17: Add lights (or LEDs)

Related Events
None

“Lights” versus “LEDs” (Some LEDs are lights?!?)

One thing that’s important to know about LEDs in MPF is that not all LEDs are configured as LEDs. :)

Taking a step back. There are two types of lighting systems in pinball machines: lamp matrices and direct-connected LEDs. All commercial pinball machines from about 1979 through 2012 (give or take) used lamp matrices (typically with 8 rows and 8 columns of lights). Historically these were used with incandescent light bulbs, (#44, #555, etc.).

However, in more recent years various manufacturers have released LED “replacement” bulbs that fit the old-style sockets but that are actually LEDs. If your machine uses a lamp matrix, then you will add your lights (whether they’re LEDs or incandescent) as *lights* via the *matrix_lights*: section of your machine config. You’ll do this even if you have LED bulbs in your lamp matrix.

Alternately, if you have directly-controlled LEDs (i.e. no lamp matrix), whether single color or RGB, then you’ll configure them as *LEDs* in the *leds*: section of your config.

The following diagram shows the different types. An easy way to tell is if your lights or LEDs have mini bayonet or mini wedge bases, they’re *Matrix Lights*, and everything else is *LEDs*:



Note that it's possible that you'll have both matrix lights and direct connected LEDs in the same machine. For example, maybe you're writing code for an existing WPC machine and you'll use the existing matrix lights as they are while also adding new direct connected LEDs for some new toys.

Loops

Todo: Have to write this section

Magnets

Related Config File Sections
<i>magnets:</i>

New in version 0.32.

- [*Monitorable Properties*](#)
- [*Related How To guides*](#)
- [*Related Events*](#)

MPF supports the ability to control precise timing for magnets which you can use to grab and release balls. It also includes the ability to set timings to “fling” a ball by grabbing, releasing, then pulsing the magnet again.

Monitorable Properties

For *dynamic values* and *conditional events*, the prefix for magnets is `device.magnets.<name>`.

active Boolean (true/false) as to whether this magnet is actively on and in the powered state.

enabled Boolean (true/false) which shows whether this ball hold is enabled.

Related How To guides

Todo: TODO

Related Events

- [*magnet_\(name\)_flinged_ball*](#)
- [*magnet_\(name\)_flinging_ball*](#)

- *magnet_(name)_grabbed_ball*
- *magnet_(name)_grabbing_ball*
- *magnet_(name)_released_ball*
- *magnet_(name)_releasing_ball*

Motors

Related Config File Sections

<i>motors:</i>

TODO

Playfields

Related Config File Sections

<i>playfields:</i>

<i>playfield_transfers:</i>

- *Monitorable Properties*
- *Related How To guides*
- *Related Events*
- *Other playfield concepts*

Believe it or not, the playfield in MPF is technically a *ball device*. This is needed since MPF wants to know where all the balls are at all times, so it needs to know which balls are “in” the playfield device.

The playfield is also responsible for tracking balls that “disappeared” from it without going into other devices—a process which kicks off the *ball search*. The default playfield ball device (called *playfield*) is created automatically based on settings in the `mpfconfig.yaml` default configuration file. Most machines only have one playfield, though if you have a mini-playfield or a head-to-head machine then you can configure additional playfield devices.

Playfields are configured in the *playfields: section* of the configuration file.

Monitorable Properties

For *dynamic values* and *conditional events*, the prefix for playfields is `device.playfields.<name>`.

available_balls todo

balls The number of balls on the playfield.

Related How To guides

Todo: TODO

Related Events

- *sw_(playfield)_active* |
- *unexpected_ball_on_(playfield)* |
- *(playfield)_active* |
- *(playfield)_ball_count_change* |
- *playfield_transfer_(playfield_transfer)_ball_transferred* |

Other playfield concepts

How MPF tracks the number of balls on a playfield

In MPF, the “playfield” is technically a ball device, just like anything else that holds a ball (the trough, the plunger lane, a VUK, etc.). Any balls that are loose and rolling around the playfield can be considered to be “in” the playfield ball device.

Most ball devices in MPF have either (1) switches that a ball sitting in the device activates while sitting there (configured as `ball_switches`: in MPF), or (2) a switch that is momentarily activated when a ball rolls over it on its way in. (Configured as an `entrance_switch`: in MPF.)

But a playfield has none of these.

However, there are many switches in a pinball machine which are only hit by a ball that’s on the playfield, and MPF uses these switches to know whether there’s a ball on the playfield.

playfield_active switch tags

In MPF, you add a tag called `playfield_active` to the list of tags for every switch which is hit by a ball that’s active on the playfield.

You do this in the `switches`: section of your machine config, like this:

```
switches:

    s_trough1:
        number:
    s_trough2:
        number:
    s_plunger_lane:
        number:
    s_standup_1:
        number:
        tags: playfield_active
    s_upper_right_rollover:
```



```
number:
  tags: playfield_active
s_ramp_enter:
  number:
    tags: playfield_active
s_ramp_made:
  number:
    tags: playfield_active
```

Note that not every switch has the `playfield_active` tag, rather, it's just used for the switches that are hit when a ball is on the playfield.

Note that all switches which can be hit by a ball on the playfield are tagged, even if they're ramp switches since a ball rolling around a ramp is a ball on the playfield.

Tracking new balls added to the playfield

MPF also uses the `playfield_active` tags to know whether a ball has successfully been ejected from a ball device to the playfield.

If a ball device ejects to a playfield that has no balls on it, then the first time a switch tagged with `playfield_active` is hit, MPF knows the ball successfully made it out of the device and onto the playfield. Ball devices also have eject timeouts which will be used to confirm that a ball was ejected to the playfield if the timeout expires and the ball has not fallen back into the device that ejected it, which is useful since it's possible for the ball to make it out of the device but then not to hit a switch right away.

The `playfield_active` tagged switches are only used to confirm ball ejections to the playfield if there are no current balls on the playfield when the device ejects a ball to it. If there is a ball (or multiple balls) on the playfield when a device ejects a ball to the playfield, then MPF doesn't know whether a hit to a `playfield_active` switch is from one of the current balls or the new ball, so in that case it always falls back to using the eject timeout to confirm that the ball successfully made it out.

These switches are used for ball search

MPF's [ball search](#) functionality uses the `playfield_active` switches to know whether a ball is stuck. (Basically every activation of one of these switches resets the ball search timer, and if that timer runs out and the player is not holding in a flipper button, then the ball search starts.)

So it's important to add the `playfield_active` tag to every switch that can be hit by a ball on the playfield.

Tagging switches with multiple playfields

If you have more than one playfield, then the "`playfield_active`" switch tag name should be adjusted to match the name of your actual playfield. For example, if you have a playfield called "`upper_playfield`", then the switches which are hit by a ball on the upper playfield should be tagged `upper_playfield_active`.

‘Playfield’ balls versus ‘balls in play’

One important concept for ball tracking to understand is that there’s a difference between the number of balls on a playfield and the “balls in play”.

Most of the time, the number of balls rolling around the playfield is the same as the number of balls in play. However this is not always the case.

For example, when the machine tilts, the player’s ball is “dead” and the number of balls in play is set to zero. But of course when that happens, there are still balls loose on the playfield which MPF has to track to make sure they all drain without getting stuck.

Also, if you have more than one playfield (like with an upper or lower playfield), then the number of balls on the individual playfields will be lower than the total number of balls in play.

Another time these two values are different is when the player shoots the ball into a lock. At that moment the playfield has no balls (and the lock has one), though there’s technically still a ball in play.

Playfield transfer

MPF Device

Plungers & Ball Launch Devices

Related Config File Sections
<i>ball_devices:</i>

A Plunger is a type of ball device. MPF supports mechanical (traditional “spring” plungers), coil-fired plungers, and combo auto/manual plungers.

Here are the options:

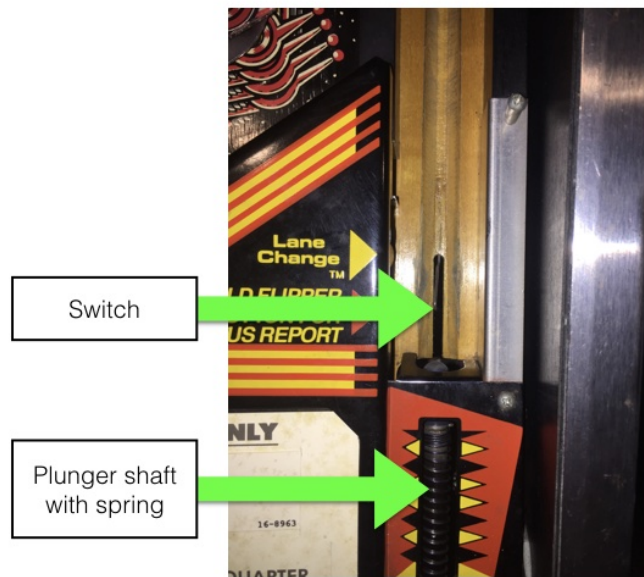
- [*Mechanical \(spring\) plungers*](#)
- [*Plunger lanes with no ball switch*](#)
- [*Coil-fired plungers / ball launchers*](#)
- [*Combo \(mechanical + coil-fired\) plungers*](#)

Since there are so many different options, you need to first identify which type of plunger or ball launch system your machine has. So look at the following pictures to match up what you have, and then follow the specific links to see how to configure MPF to use it in your machine.

Option 1: Spring plunger with ball switch

The most “traditional” style plunger is a spring-powered mechanical plunger lane. In modern machines, there’s a switch at the bottom of the plunger lane which is activated by a ball sitting in the plunger lane waiting to be plunged.

Here’s an example of this from a Pin*Bot machine:

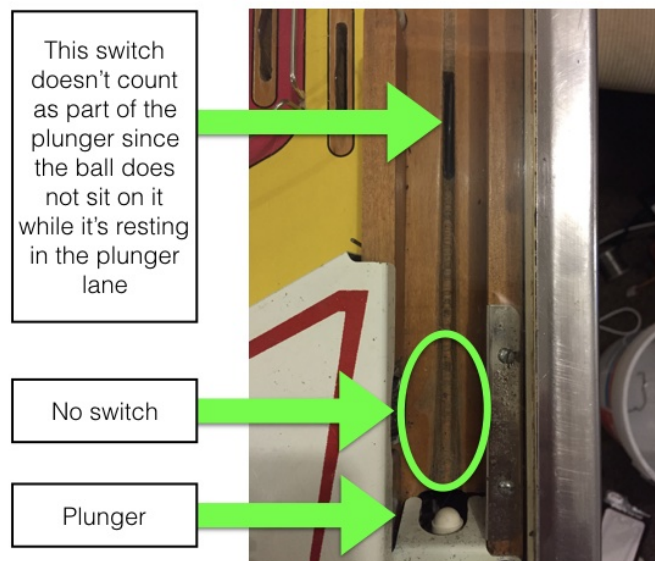


If you have this type of spring-powered plunger with a switch that's active when a ball is sitting in it ready to be plunged, follow the [Mechanical \(spring\) plungers](#) guide to configure it in MPF.

Option 2: Spring plunger with no ball switch

Older pinball machines (typically those that only have one ball) have what appear to be traditional plungers like in Option 1, but if you look closely, you'll notice that there is no switch which is active when the ball is sitting in the plunger lane.

Here's an example of this from Gottlieb Big Shot:

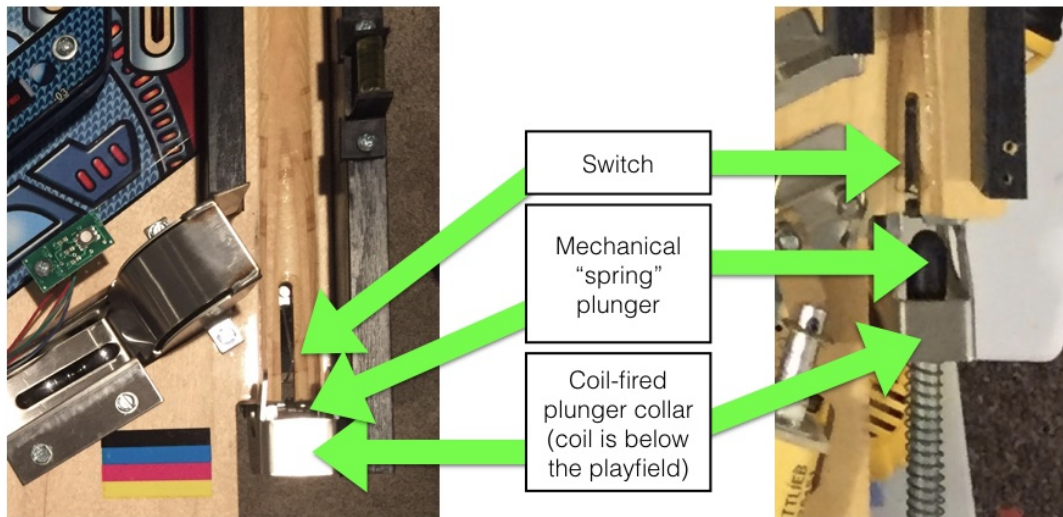


If you have this type of spring-powered plunger with **no** switch that's active when a ball is sitting in it ready to be plunged, follow the [Plunger lanes with no ball switch](#) guide to configure it in MPF.

Option 3: Combo spring plunger with coil-fired autolauncher

Many modern machines have a combination-style plunger which combines a mechanical spring-powered plunger with an autolauncher coil. These types of plungers allow game to decide whether the player should manually pull back on the plunger handle to launch the ball with spring power or whether the game should pulse a coil to eject the ball into play.

Here are two examples of slightly different versions of these, the left from a Gottlieb Brooks 'n Dunn machine, and the right from a Stern Star Trek Premium:

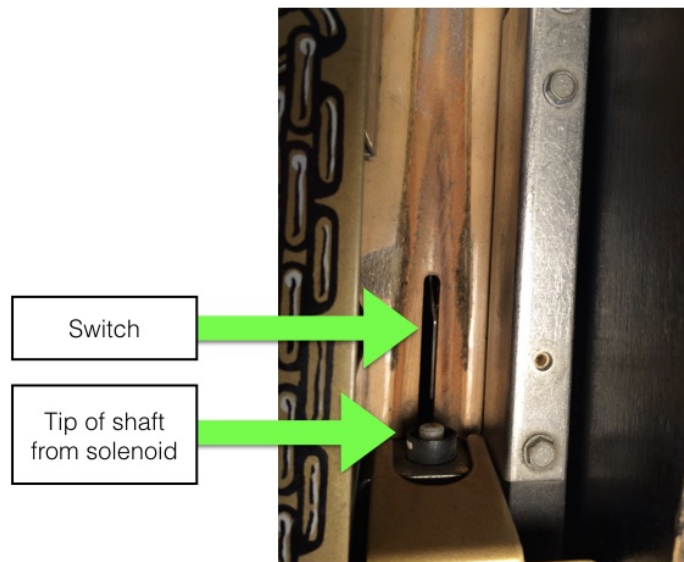


If you have this type of auto/manual combo plunger, follow the [Combo \(mechanical + coil-fired\) plungers](#) guide to configure it in MPF.

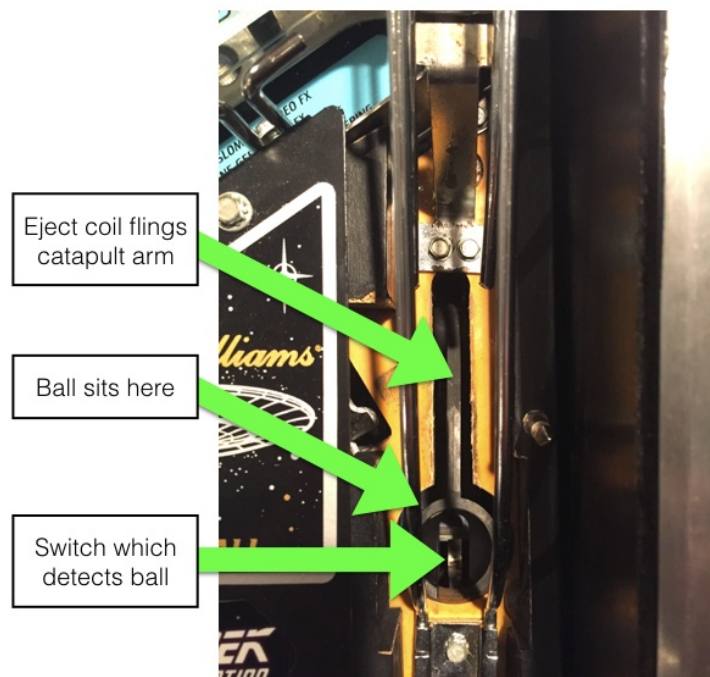
Option 4: Coil-fired plunger (no mechanical spring option)

The final plunger option is the fully automatic coil-fired option that has no mechanical spring-based option.

There are a few different physical forms of this. Here's a typical example from Judge Dredd where a coil shaft with a plastic tip is pulsed to launch the ball directly:



And here's an example from Williams Star Trek: The Next Generation which uses a catapult-style mechanism in order to launch the ball into play.



Note that both of these options are “identical” as far as MPF is concerned. They both have switches which are active when a ball is able to be launched, they both pulse coils to launch the ball, and neither one has a manual plunge option.

If you have this type of coil-powered plunger, follow the [Coil-fired plungers / ball launchers](#) guide to configure it in MPF.

Related How To Guides

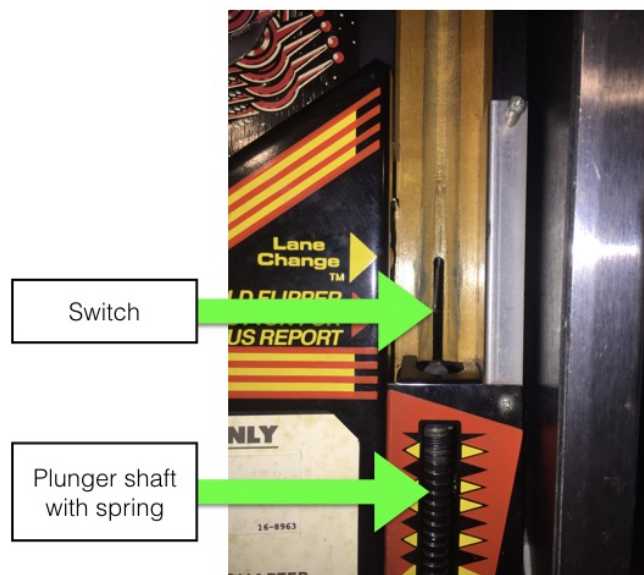
Tutorial step 8: Add your plunger lane
--

Related Events
<i>balldevice_ball_missing</i>
<i>balldevice_balls_available</i>
<i>balldevice_(balls)_ball_missing.</i>
<i>balldevice_captured_from_(device)</i>
<i>balldevice_(name)_ball_eject_attempt</i>
<i>balldevice_(name)_ball_eject_failed</i>
<i>balldevice_(name)_ball_eject_success</i>
<i>balldevice_(name)_ejecting_ball</i>

Mechanical (spring) plungers

This guide shows you how to configure a traditional mechanical spring plunger with MPF.

This guide is for use with a plunger lane that has a switch in the lane which is activated by a ball waiting to be plunged, like this:



If you have a mechanical spring plunger but you do NOT have a switch there, then follow the [Plunger lanes with no ball switch](#) guide instead.

If you have a mechanical spring plunger that also has an “auto launch” coil fired option, then follow the [Combo \(mechanical + coil-fired\) plungers](#) guide instead.

1. Add the switch

The first step is to add your plunger lane switches to the switches: section of your machine config file. Here's an example:

```
switches:
  s_plunger_lane:
    number: 2-6
```


Note that we configured this switches as number 2-6, but you should use the actual switch numbers for your control system that the switches are connected to. (See [How to configure “number:” settings](#) for instructions for each type of control system.)

Be sure to set the type: NC if this switch is an opto and to configure the other switch settings as needed.

2. Add your plunger ball device

Remember a [ball device](#) is anything in your pinball machine that holds a ball (even if it’s just for a short time). So your plunger lane is a ball device.

In this case, you can add an entry for your plunger to the `ball_devices:` section of your machine-wide config, and then create sub entries for the ball switch.

Here’s an example. Note that in this case, we’ve left out the other ball devices (such as your trough and/or drain):

```
ball_devices:
  bd_plunger:
    ball_switches: s_plunger_lane
```

In the example above, we named the plunger device `bd_plunger`, but of course you can name it whatever you want. You might use `bd_right_plunger` and `bd_left_plunger` for a game like *Red & Ted’s Road Show* that has plunger lanes on both sides.

Note that the `ball_switches:` entry will just be a single switch, which is fine. Since there’s only one switch listed in the `ball_switches:` section, that will tell MPF that this device can hold one ball.

3. Add the mechanical eject setting

Most ball devices in MPF have a coil which MPF pulses to eject a ball from the device. But in the case of a mechanical spring-powered plunger, there is no coil to eject the ball.

In this case, you have to tell MPF that this device has a mechanical eject option, which basically lets MPF know that the ball might suddenly disappear from this device, and when that happens, and eject attempt has been made.

To do that, add `mechanical_eject: true` to your plunger device, like this:

```
ball_devices:
  bd_plunger:
    ball_switches: s_plunger_lane
    mechanical_eject: true
```

4. Configure the eject confirmation, target & timeouts

Next you need to configure some settings that will let your plunger know whether ball launch events were successful.

The first setting is called `eject_targets:`. (You may remember this from when you [configured your trough or drain device](#).) This setting is a list of one (or more, if there’s a diverter) ball devices that your plunger lane ejects into.

In probably 99% of cases, the plunger device only ejects to the playfield. In that case you do *not* need to configure your `eject_targets`: because the playfield is the default setting.

However, if your plunger lane ejects to some other device (maybe another launcher or a subway or something) other than the playfield, then you'd configure that here.

Next up is the `confirm_eject_type`: which is how MPF knows that a ball really made it out of the plunger and won't fall back in.

In most cases, the default setting of "target" is fine (because that means that MPF just watches for the target device (from above) to get a ball, and when it does, it assumes the eject from this device was successful.

However, plunger lanes that eject to the playfield sometimes have a switch that's activated when the ball leaves the plunger. You can use this switch with a few caveats:

- If this switch has been hit, it means the ball is out for sure, and it's not possible for it to roll back.
- This switch must always be hit, e.g. the ball can't sneak around it.
- No other balls should be able to hit this switch while they're in play.

What this means is that this switch is pretty limited and almost never used.

Finally, you need to configure the `eject_timeouts`: which is a time setting for how long MPF will wait to confirm the eject. If a ball re-enters that device before the timeout happens, then MPF assumes the eject failed and will try it again.

For the `eject_timeouts`:, you want to figure out what the MAXIMUM time is that a ball could be ejected from the plunger but still not make it all the way out and then fall back into the plunger. You'll have to play with this setting in your machine, but in most machines it's probably around 3s.

Here are some examples of these settings in action.

First, for a typical coil-fired plunger lane / catapult that ejects the ball directly to the playfield: (This is probably 99% of all cases)

```
ball_devices:
  bd_plunger:
    ...
    eject_timeouts: 3s
```

Next, for a coil-fired plunger that has a switch at the exit of the plunger lane that is only hit if the ball has made it out of the plunger and cannot be hit by a random ball on the playfield:

```
ball_devices:
  bd_plunger:
    ...
    confirm_eject_type: switch
    confirm_eject_switch: s_plunger_lane_exit
    eject_timeouts: 3s
```

Next, if your plunger lane ejects into another ball device (a cannon, in this case):

```
ball_devices:
  bd_plunger:
    ...
    eject_targets: bd_cannon
    eject_timeouts: 2s
```


5. Set your trough/drain device eject_targets

Once you have your plunger device set up, you need to go back to your trough or ball drain device and add the new plunger to your trough's `eject_targets`:, like this:

```
ball_devices:
  bd_trough:
    ball_switches: s_trough1, s_trough2, s_trough3, s_trough4, s_trough_jam
    eject_coil: c_trough_eject
    tags: trough, home, drain
    jam_switch: s_trough_jam
    eject_coil_jam_pulse: 15ms
    eject_targets: bd_plunger
```

Of course you'd add the name that you gave your plunger device, which could be something like "bd_catapult" or whatever you called it.

Also, if you have a two-stage drain (like a System 11 machine), you'd add this to the second device (the one that feeds the plunger).

6. Add the ball_add_live_tag

Next you need to add a tag to your plunger lane ball device called `ball_add_live` which is used to tell MPF that this ball device is used to add a new ball into play.

To do that, add the tags section to your new plunger ball device, like this:

```
ball_devices:
  bd_plunger:
    ...
    tags: ball_add_live
```

7. Tag your playfield switches

Since the plunger lane ejects balls to the playfield, it's important that you have your playfield switches tagged properly since that's how MPF knows that a ball is loose on the playfield.

See the [How MPF tracks the number of balls on a playfield](#) documentation for details.

Complete config example

Here's a complete machine config with a "standard" coil-fired plunger that ejects the ball directly to the playfield. Note that this config does not include the switches and coils for the trough.

This config is what probably 99% of machines with coil-fired plungers will use:

```
switches:
  s_plunger_lane:
    number: 2-6

ball_devices:
```



```

bd_trough:
    ball_switches: s_trough1, s_trough2, s_trough3, s_trough4, s_trough_jam
    eject_coil: c_trough_eject
    tags: trough, home, drain
    jam_switch: s_trough_jam
    eject_coil_jam_pulse: 15ms
    eject_targets: bd_plunger

bd_plunger:
    ball_switches: s_plunger_lane
    mechanical_eject: true
    eject_timeouts: 3s
    tags: ball_add_live

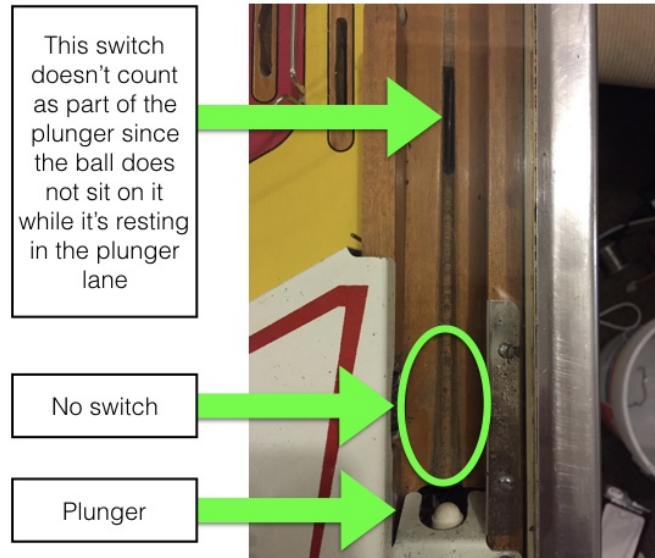
```

Plunger lanes with no ball switch

Modern pinball machines have a switch in the plunger lane that tells the software that a ball is sitting in the plunger lane waiting to be plunged.

This document describes how you configure MPF to work with plunger lanes when the plunger lane has no switch which is active when a ball is sitting at the plunger. (This is common in older single-ball machines, including many EM and early solid state machines.)

Here's an example from a Gottlieb Big Shot



```

#config_version=4

coils:
    trough_eject:
        number:

switches:
    s_trough_1:

```



```
    number:
s_trough_2:
    number:
s_trough_3:
    number:
s_trough_4:
    number:
s_trough_jam:
    number:
s_playfield:
    number:
    tags: playfield_active

ball_devices:
  trough:
    eject_coil: trough_eject
    ball_switches: s_trough_1, s_trough_2, s_trough_3, s_trough_4
    debug: true
    tags: trough, drain, home, ball_add_live
```

1. Configure your trough / ball drain

MPF's plunger lanes work hand-in-hand with the trough / ball drain devices. So if you haven't configured that yet, go back and *do that now*, then come back here and configure your plunger.

2. Understand that your plunger is *not* a ball device

Most pinball machines have a switch in the plunger lane which is used to tell MPF that there's a ball in the plunger waiting to be plunged.

However, this How To guide is for plunger lanes with no ball switch. (If your plunger lane has a ball switch, then follow the *Mechanical (spring) plungers* guide instead.)

In machines where the plunger lane does not have a ball switch, that means that MPF has no idea whether a ball is in the plunger lane. That's totally fine, and MPF can support that no problem. However, in this case, *you do not configure your plunger lane as a ball device!*

Instead the plunger lane area is considered part playfield, so a ball in the plunger lane that's not sitting on a switch is just like any other area of the playfield where the ball might be rolling around while it's not on a switch.

3. Add a ball_add_live tag to your trough

In machines where the plunger lane is a ball device, we add a tag called ball_add_live to the plunger ball device. The "ball_add_live" tag is used to tell MPF that this is the device which is used (by default) to add a live ball into play.

But since your plunger lane with no switch is not a ball device, that means we have to go back to the trough ball device and add the ball_add_live tag to it. (Your trough device will already have the trough tag applied to it, and depending on how your machine is laid it, it might also have the drain tag applied.)

So add `ball_add_live` to your trough now.

Then when MPF needs to add a live ball into play, it will eject a ball from the trough and you're all set!

4. What happens if MPF starts with a ball in the plunger?

One of the downsides to not having a switch in the plunger lane is that MPF has no way of knowing if there's a ball in there. Throughout the ordinary course of operation, this is fine, because MPF "knows" that the trough ejected a ball, and it "knows" when the ball is on the playfield, so if the trough has ejected a ball and that ball hasn't yet entered the playfield, MPF can "assume" that ball is in the plunger lane.

However, what happens if MPF boots up from scratch and there's a ball in the plunger lane? In that case, the ball is not activating any switches, so MPF really has no idea if the ball is in the plunger line (which is fine) or if the ball is stuck somewhere on the playfield (which is not fine).

TODO: This does not work yet and will be fixed soon.

5. Configuring the ball save timer

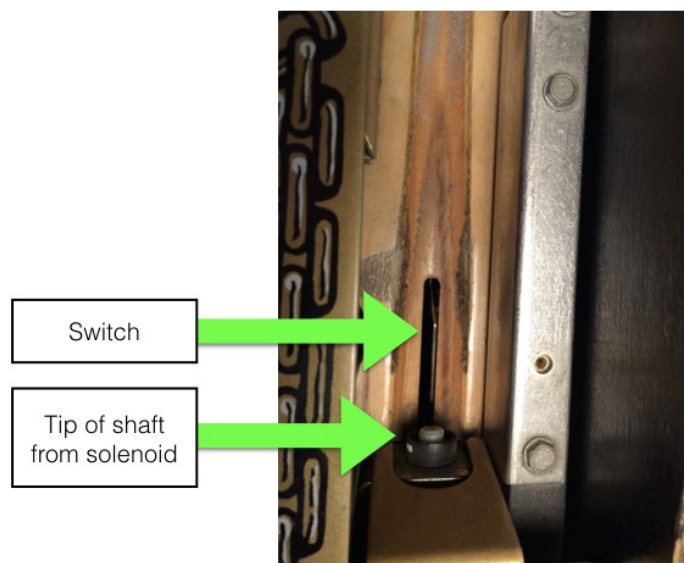
Be sure to set your ball save start event based on a tag from your switches tagged with `playfield_active` rather than `ball_starting` or your trough eject confirmation, since you don't want the timer to start running when the ball is sitting in the plunger lane.

See the [Ball Saves](#) documentation for details.

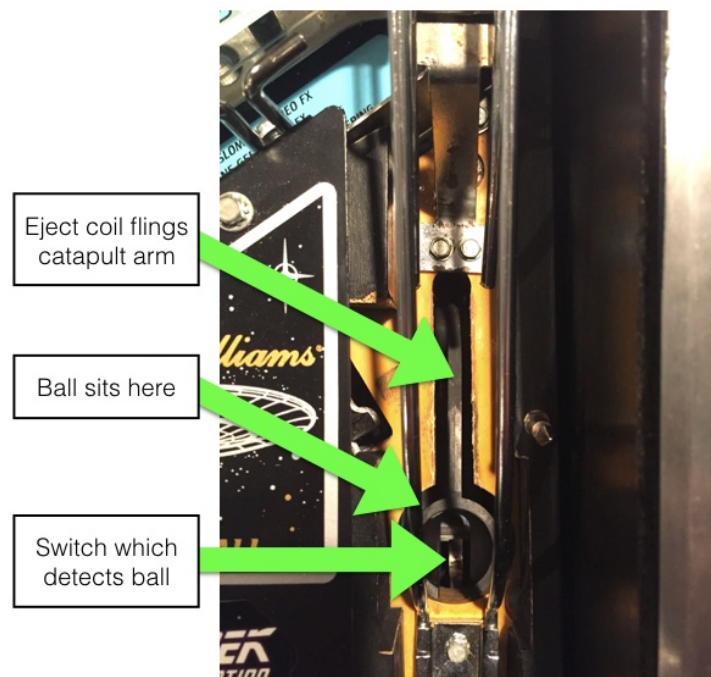
Coil-fired plungers / ball launchers

Many modern pinball machines use some kind of "launch" button to launch the ball into play.

Sometimes these look more-or-less like traditional plunger lanes, except there's a solenoid instead of a spring-powered plunger, like this:



Other times these are more like “catapult” devices with a coil attached to the arm to launch the ball into play:



Note that if you have a coil-fired ball launcher that’s combined with a spring plunger (giving the option for manual spring launches or machine-controlled auto launches, stop here and follow the [Combo \(mechanical + coil-fired\) plungers](#) guide instead.

1. Add the switches

The first step is to add your plunger’s switches to the switches: section of your machine config file. Create an entry in the switches: section for both the switch in the device that’s active when a ball is sitting in the plunger ready to be launched, and also create the entry for the switch connected to the button the player hits to launch the ball.

Here’s an example:

```
switches:
  s_plunger_lane:
    number: 2-6
  s_launch_button:
    number: 1-5
```

Note that we configured this switches with numbers 2-6 and 1-5, but you should use the actual switch numbers for your control system that the switches are connected to. (See [How to configure “number:” settings](#) for instructions for each type of control system.)

Be sure to set the type: NC if either of these switches is an opto and to configure the other switch settings as needed.

2. Add the coil

Next, create an entry in your `coils:` section of your machine config file for your plunger's eject coil. Again, the name doesn't matter. We'll call this `c_plunger` and enter it like this:

```
coils:
  c_plunger:
    number: 2-1
    pulse_ms: 20
```

Again, the `number:` entries in your config will vary depending on your actual hardware, and again, you can pick whatever name you want for your coil.

You'll also note that we went ahead and entered a `pulse_ms:` value of 20 which will override the default pulse time of 10ms. It's hard to say at this point what value you'll actually need. You can always adjust this at any time. You can play with the exact values in a bit once we finish getting everything set up.

3. Add your plunger / launcher ball device

Remember a *ball device* is anything in your pinball machine that holds a ball (even if it's just for a short time). So your plunger lane / ball launcher is a ball device.

In this case, you can add an entry for your plunger to the `ball_devices:` section of your machine-wide config, and then create sub entries for the ball switch and eject coil.

Here's an example. Note that in this case, we've left out the other ball devices (such as your trough and/or drain):

```
ball_devices:
  bd_plunger:
    ball_switches: s_plunger_lane
    eject_coil: c_plunger
```

In the example above, we named the plunger device `bd_plunger`, but of course you can name it whatever you want. You might use `bd_catapult` for a catapult-style launcher, or `bd_right_plunger` and `bd_left_plunger` for a game like Judge Dredd that has plunger lanes on both sides.

Note that the `ball_switches:` entry will just be a single switch. It's the switch that's active when a ball is sitting in the plunger waiting to be launched. (This is NOT the switch the player hits to launch the ball.)

Since there's only one switch listed in the `ball_switches:` section, that will tell MPF that this device can hold one ball.

4. Configure the launch switch

Next you need to configure the plunger lane so it launches the ball when the player hits the launch button. In MPF terms, this is technically the plunger "ejecting" the ball, so we use a setting called `player_controlled_eject_event:` which you add to your plunger.

At this point, you might be wondering why we configure a player controlled eject "event". Why is it an "event" and not a "switch"?

This is due to MPF's flexibility to support the myriad of different types of machines in the world.

For example, some machines launch the ball when a player hits a button. Others launch it when the player *releases* a button. Still others play a little show then launch. Etc.

So we decided, “Hey, we have this great events system in MPF, so let’s just use that.”

Remember that by default, there are “active” events that are posted when a switch becomes active, and “inactive” events that are posted when a switch that was active becomes inactive.

4.1 Launching the ball when a player hits the launch button

Assuming the switch tied to the launch button (or gun trigger or fishing rod button or whatever you have) is called `s_launch_button`, then that means an event called `s_launch_button_active` will be posted as soon as that switch is hit. In that case, you’d configure your plunger like this:

```
ball_devices:
  bd_plunger:
    ball_switches: s_plunger_lane
    eject_coil: c_plunger
    player_controlled_eject_event: s_launch_button_active
```

Pretty straightforward.

4.2 Launching the ball when a player releases the launch button

If you want to launch the ball into play when the player *releases* the launch button, then just use that switch’s inactive event:

```
ball_devices:
  bd_plunger:
    ball_switches: s_plunger_lane
    eject_coil: c_plunger
    player_controlled_eject_event: s_launch_button_inactive
```

Note that whenever the `player_controlled_eject_event:` is used, MPF has to specifically enable the ability for that event to eject a ball. In other words, you don’t have to worry about the player hitting that switch to launch extra balls into play, and it’s fine if that event is posted in other places in your game.

5. Configure the eject confirmation, target & timeouts

Next you need to configure some settings that will let your plunger know whether ball launch events were successful.

The first setting is called `eject_targets:`. (You may remember this from when you [configured your trough or drain device](#).) This setting is a list of one (or more, if there’s a diverter) ball devices that your plunger lane ejects into.

In probably 99% of cases, the plunger device only ejects to the playfield. In that case you do *not* need to configure your `eject_targets:` because the playfield is the default setting.

However, if your plunger lane ejects to some other device (maybe another launcher or a subway or something) other than the playfield, then you’d configure that here.

Next up is the `confirm_eject_type`: which is how MPF knows that a ball really made it out of the plunger and won't fall back in.

In most cases, the default setting of "target" is fine (because that means that MPF just watches for the target device (from above) to get a ball, and when it does, it assumes the eject from this device was successful.

However, plunger lanes that eject to the playfield sometimes have a switch that's activated when the ball leaves the plunger. You can use this switch with a few caveats:

- If this switch has been hit, it means the ball is out for sure, and it's not possible for it to roll back.
- This switch must always be hit, e.g. the ball can't sneak around it.
- No other balls should be able to hit this switch while they're in play.

What this means is that this switch is pretty limited and almost never used.

Finally, you need to configure the `eject_timeouts`: which is a time setting for how long MPF will wait to confirm the eject. If a ball re-enters that device before the timeout happens, then MPF assumes the eject failed and will try it again.

For the `eject_timeouts`:, you want to figure out what the MAXIMUM time is that a ball could be ejected from the plunger but still not make it all the way out and then fall back into the plunger. You'll have to play with this setting in your machine, but in most machines it's probably around 3s.

Here are some examples of these settings in action.

First, for a typical coil-fired plunger lane / catapult that ejects the ball directly to the playfield: (This is probably 99% of all cases)

```
ball_devices:
    bd_plunger:
        ...
        eject_timeouts: 3s
```

Next, for a coil-fired plunger that has a switch at the exit of the plunger lane that is only hit if the ball has made it out of the plunger and cannot be hit by a random ball on the playfield:

```
ball_devices:
    bd_plunger:
        ...
        confirm_eject_type: switch
        confirm_eject_switch: s_plunger_lane_exit
        eject_timeouts: 3s
```

Next, if your plunger lane ejects into another ball device (a cannon, in this case):

```
ball_devices:
    bd_plunger:
        ...
        eject_targets: bd_cannon
        eject_timeouts: 2s
```


6. Set your trough/drain device eject_targets

Once you have your plunger device set up, you need to go back to your trough or ball drain device and add the new plunger to your trough's `eject_targets:`, like this:

```
ball_devices:
  bd_trough:
    ball_switches: s_trough1, s_trough2, s_trough3, s_trough4, s_trough_jam
    eject_coil: c_trough_eject
    tags: trough, home, drain
    jam_switch: s_trough_jam
    eject_coil_jam_pulse: 15ms
    eject_targets: bd_plunger
```

Of course you'd add the name that you gave your plunger device, which could be something like "bd_catapult" or whatever you called it.

Also, if you have a two-stage drain (like a System 11 machine), you'd add this to the second device (the one that feeds the plunger).

7. Add the ball_add_live_tag

Next you need to add a tag to your plunger lane ball device called `ball_add_live` which is used to tell MPF that this ball device is used to add a new ball into play.

To do that, add the tags section to your new plunger ball device, like this:

```
ball_devices:
  bd_plunger:
    ...
    tags: ball_add_live
```

8. Tag your playfield switches

Since the plunger lane ejects balls to the playfield, it's important that you have your playfield switches tagged properly since that's how MPF knows that a ball is loose on the playfield.

See the [How MPF tracks the number of balls on a playfield](#) documentation for details.

Complete config example

Here's a complete machine config with a "standard" coil-fired plunger that ejects the ball directly to the playfield. Note that this config does not include the switches and coils for the trough.

This config is what probably 99% of machines with coil-fired plungers will use:

```
switches:
  s_plunger_lane:
    number: 2-6
  s_launch_button:
    number: 1-5
```



```

coils:
  c_plunger:
    number: 2-1
    pulse_ms: 20

ball_devices:

  bd_trough:
    ball_switches: s_trough1, s_trough2, s_trough3, s_trough4, s_trough_jam
    eject_coil: c_trough_eject
    tags: trough, home, drain
    jam_switch: s_trough_jam
    eject_coil_jam_pulse: 15ms
    eject_targets: bd_plunger

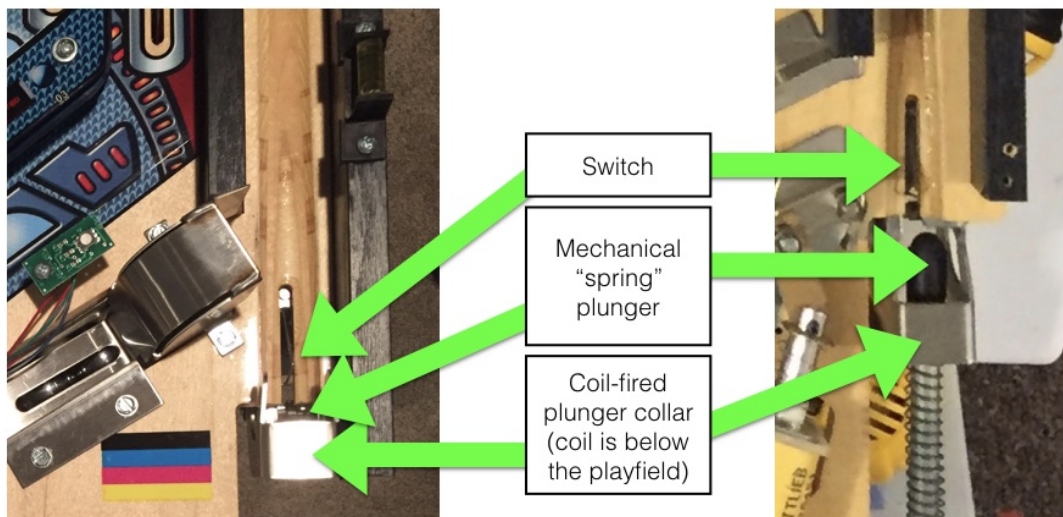
  bd_plunger:
    ball_switches: s_plunger_lane
    eject_coil: c_plunger
    player_controlled_eject_event: s_launch_button_active
    eject_timeouts: 3s
    tags: ball_add_live

```

Combo (mechanical + coil-fired) plungers

This guide explains how to configure a “combo” plunger lane which has both a mechanical spring-powered plunger as well as a coil-fired auto plunge option.

Here’s an example of this:



If you have a purely mechanical plunger with no autolaunch option, follow the [Mechanical \(spring\) plungers](#) guide instead. If you have a standard coil-fired plunger or launch device with no mechanical spring plunger, follow the [Coil-fired plungers / ball launchers](#) guide instead.

Note: If you’re reading through this guide and comparing it to the guide for the coil-fired plunger lane, you’ll find that they’re almost identical, except that this guide adds the `mechanical_eject: true`

setting to the plunger.

1. Add the switches

The first step is to add your plunger's switches to the `switches:` section of your machine config file. Create an entry in the `switches:` section for the switch which is in the plunger lane that's activated by a ball waiting to be plunged.

You might also have a button which the player can hit to launch balls into play. Some machines have this (Like *Stern Star Trek* with the button on the apron), while others only let the player launch the ball with spring plunger and they use the coil for ball save and multiballs only.

So add one (or both, if you have a launch button) to your machine config if you haven't done so already:

```
switches:
  s_plunger_lane:
    number: 2-6
  s_launch_button:
    number: 1-5
```

Note that we configured this switches with numbers 2-6 and 1-5, but you should use the actual switch numbers for your control system that the switches are connected to. (See [How to configure "number:" settings](#) for instructions for each type of control system.)

Be sure to set the type: NC if either of these switches is an opto and to configure the other switch settings as needed.

2. Add the coil

Next, create an entry in your `coils:` section of your machine config file for your plunger lane's eject coil. Again, the name doesn't matter. We'll call this `c_plunger` and enter it like this:

```
coils:
  c_plunger:
    number: 2-1
    pulse_ms: 20
```

Again, the `number:` entries in your config will vary depending on your actual hardware, and again, you can pick whatever name you want for your coil.

You'll also note that we went ahead and entered a `pulse_ms:` value of 20 which will override the default pulse time of 10ms. It's hard to say at this point what value you'll actually need. You can always adjust this at any time. You can play with the exact values in a bit once we finish getting everything set up.

3. Add your plunger / launcher ball device

Remember a [ball device](#) is anything in your pinball machine that holds a ball (even if it's just for a short time). So your plunger lane / ball launcher is a ball device.

In this case, you can add an entry for your plunger to the `ball_devices:` section of your machine-wide config, and then create sub entries for the ball switch and eject coil.

Here's an example. Note that in this case, we've left out the other ball devices (such as your trough and/or drain):

```
ball_devices:
  bd_plunger:
    ball_switches: s_plunger_lane
    eject_coil: c_plunger
```

In the example above, we named the plunger device *bd_plunger*, but of course you can name it whatever you want. You might use *bd_catapult* for a catapult-style launcher, or *bd_right_plunger* and *bd_left_plunger* for a game like Judge Dredd that has plunger lanes on both sides.

Note that the *ball_switches:* entry will just be a single switch. It's the switch that's active when a ball is sitting in the plunger waiting to be launched. (This is NOT the switch the player hits to launch the ball if you have one of those.)

Since there's only one switch listed in the *ball_switches:* section, that will tell MPF that this device can hold one ball.

4. Add the mechanical eject setting

Since your plunger ball device has an option for the player to manually plunge the ball with the spring rod, we need to give MPF a "heads up" that a ball sitting in the plunger lane might suddenly disappear, and that when that happens, that means the player has attempted to eject the ball from this device.

To do that, add *mechanical_eject: true* to your plunger device, like this:

```
ball_devices:
  bd_plunger:
    ball_switches: s_plunger_lane
    eject_coil: c_plunger
    mechanical_eject: true
```

5. (Optional) Configure the launch switch

If your machine also has a launch button which you'd like to (optionally) use for the player to hit to launch the ball into play with the plunger lane's eject coil, then you can add a setting called *player_controlled_eject_event:*.

At this point, you might be wondering why we configure a player controlled eject "event". Why is it an "event" and not a "switch"?

This is due to MPF's flexibility to support the myriad of different types of machines in the world.

For example, some machines launch the ball when a player hits a button. Others launch it when the player releases a button. Still others play a little show then launch. Etc.

So we decided, "Hey, we have this great events system in MPF, so let's just use that."

Remember that by default, there are "active" events that are posted when a switch becomes active, and "inactive" events that are posted when a switch that was active becomes inactive.

5.1 Launching the ball when a player hits the launch button

Assuming the switch tied to the launch button (or gun trigger or fishing rod button or whatever you have) is called *s_launch_button*, then that means an event called *s_launch_button_active* will be posted as soon as that switch is hit. In that case, you'd configure your plunger like this:

```
ball_devices:
  bd_plunger:
    ball_switches: s_plunger_lane
    eject_coil: c_plunger
    mechanical_eject: true
    player_controlled_eject_event: s_launch_button_active
```

Pretty straightforward.

5.2 Launching the ball when a player releases the launch button

If you want to launch the ball into play when the player *releases* the launch button, then just use that switch's inactive event:

```
ball_devices:
  bd_plunger:
    ball_switches: s_plunger_lane
    eject_coil: c_plunger
    mechanical_eject: true
    player_controlled_eject_event: s_launch_button_inactive
```

Note that whenever the `player_controlled_eject_event:` is used, MPF has to specifically enable the ability for that event to eject a ball. In other words, you don't have to worry about the player hitting that switch to launch extra balls into play, and it's fine if that event is posted in other places in your game.

6. Configure the eject confirmation, target & timeouts

Next you need to configure some settings that will let your plunger know whether ball launch events were successful.

The first setting is called `eject_targets:`. (You may remember this from when you [configured your trough or drain device](#).) This setting is a list of one (or more, if there's a diverter) ball devices that your plunger lane ejects into.

In probably 99% of cases, the plunger device only ejects to the playfield. In that case you do *not* need to configure your `eject_targets:` because the playfield is the default setting.

However, if your plunger lane ejects to some other device (maybe another launcher or a subway or something) other than the playfield, then you'd configure that here.

Next up is the `confirm_eject_type:` which is how MPF knows that a ball really made it out of the plunger and won't fall back in.

In most cases, the default setting of "target" is fine (because that means that MPF just watches for the target device (from above) to get a ball, and when it does, it assumes the eject from this device was successful.

However, plunger lanes that eject to the playfield sometimes have a switch that's activated when the ball leaves the plunger. You can use this switch with a few caveats:

- If this switch has been hit, it means the ball is out for sure, and it's not possible for it to roll back.
- This switch must always be hit, e.g. the ball can't sneak around it.
- No other balls should be able to hit this switch while they're in play.

What this means is that this switch is pretty limited and almost never used.

Finally, you need to configure the `eject_timeouts`: which is a time setting for how long MPF will wait to confirm the eject. If a ball re-enters that device before the timeout happens, then MPF assumes the eject failed and will try it again.

For the `eject_timeouts`:, you want to figure out what the MAXIMUM time is that a ball could be ejected from the plunger but still not make it all the way out and then fall back into the plunger. You'll have to play with this setting in your machine, but in most machines it's probably around 3s.

Here are some examples of these settings in action.

First, for a typical coil-fired plunger lane / catapult that ejects the ball directly to the playfield: (This is probably 99% of all cases)

```
ball_devices:
    bd_plunger:
        ...
        eject_timeouts: 3s
```

Next, for a coil-fired plunger that has a switch at the exit of the plunger lane that is only hit if the ball has made it out of the plunger and cannot be hit by a random ball on the playfield:

```
ball_devices:
    bd_plunger:
        ...
        confirm_eject_type: switch
        confirm_eject_switch: s_plunger_lane_exit
        eject_timeouts: 3s
```

Next, if your plunger lane ejects into another ball device (a cannon, in this case):

```
ball_devices:
    bd_plunger:
        ...
        eject_targets: bd_cannon
        eject_timeouts: 2s
```

7. Set your trough/drain device eject_targets

Once you have your plunger device set up, you need to go back to your trough or ball drain device and add the new plunger to your trough's `eject_targets`:, like this:

```
ball_devices:
    bd_trough:
        ball_switches: s_trough1, s_trough2, s_trough3, s_trough4, s_trough_jam
        eject_coil: c_trough_eject
        tags: trough, home, drain
```



```
jam_switch: s_trough_jam
eject_coil_jam_pulse: 15ms
eject_targets: bd_plunger
```

Of course you’d add the name that you gave your plunger device, which could be something like “bd_catapult” or whatever you called it.

Also, if you have a two-stage drain (like a System 11 machine), you’d add this to the second device (the one that feeds the plunger).

8. Add the ball_add_live_tag

Next you need to add a tag to your plunger lane ball device called ball_add_live which is used to tell MPF that this ball device is used to add a new ball into play.

To do that, add the tags section to your new plunger ball device, like this:

```
ball_devices:
  bd_plunger:
    ...
    tags: ball_add_live
```

9. Tag your playfield switches

Since the plunger lane ejects balls to the playfield, it’s important that you have your playfield switches tagged properly since that’s how MPF knows that a ball is loose on the playfield.

See the [How MPF tracks the number of balls on a playfield](#) documentation for details.

Complete config example

Here’s a complete machine config with a “standard” coil-fired plunger that ejects the ball directly to the playfield. Note that this config does not include the switches and coils for the trough.

This config is what probably 99% of machines with coil-fired plungers will use:

```
switches:
  s_plunger_lane:
    number: 2-6
  s_launch_button:
    number: 1-5

coils:
  c_plunger:
    number: 2-1
    pulse_ms: 20

ball_devices:

  bd_trough:
    ball_switches: s_trough1, s_trough2, s_trough3, s_trough4, s_trough_jam
    eject_coil: c_trough_eject
```



```

tags: trough, home, drain
jam_switch: s_trough_jam
eject_coil_jam_pulse: 15ms
eject_targets: bd_plunger

bd_plunger:
  ball_switches: s_plunger_lane
  eject_coil: c_plunger
  mechanical_eject: true
  player_controlled_eject_event: s_launch_button_active
  eject_timeouts: 3s
  tags: ball_add_live

```

Pop Bumpers

TODO

Rollover Switches

TODO

Score Reels

Related Config File Sections
<i>score_reels:</i>
<i>score_reel_groups:</i>

TODO

Related How To Guides
TODO

Related Events
<i>reel_(name)_advance</i>
<i>reel_(name)_hw_value</i>
<i>reel_(name)_ready</i>
<i>reel_(name)_resync</i>
<i>scorereelgroup_(name)_resync</i>
<i>scorereelgroup_(name)_rollover</i>
<i>scorereelgroup_(name)_valid</i>

Score reel group

MPF Device

Servos

Related Config File Sections

<i>servos:</i>

TODO

- *[Monitorable Properties](#)*
- *[Related How To guides](#)*
- *[Related Events](#)*

Monitorable Properties

For *[dynamic values](#)* and *[conditional events](#)*, the prefix for servos is `device.servos.<name>`.

position The current position of this servo, on a scale from 0.0 to 1.0.

Related How To guides

Todo: TODO

Related Events

None

Slingshots

TODO

Spinners

TODO

Stepper Motors

TODO

Switches

Related Config File Sections
<i>switches:</i>
<i>switch_overwrites:</i>

- [*Switch Concepts*](#)
- [*Monitorable Properties*](#)
- [*Related How To guides*](#)
- [*Related Events*](#)

MPF's *switch* device represents a switch in a pinball machine. This device is used for switches, including cabinet buttons, rollovers, targets, optos, trough switches, DIP switches, etc.

MPF supports all types of switches found in all generations of pinball machines, including matrix switches, direct switches, Fliptronics switches, switches connected to I/O boards, etc.

Switches only have two states: *active* and *inactive*. (We don't say "open" or "closed" because sometimes switches are normally-closed which mean they're actually active when they're open.) In MPF, you configure your switches in the *switches:* section of your machine configuration file, including options (like whether the switch is "active" when it's in the open state or the closed state.)

You can also configure debounce settings for each switch, which controls how MPF responds to switch events. Saying that a switch has to be "debounced" means that the pinball controller makes sure the switch is actually in its current state for a few milliseconds before it send the switch event to MPF. This can be useful to filter out unwanted or phantom switch events which might happen due to electrical interference or other little weird things.

Most switches in pinball machines are debounced except for the ones that you absolutely want to fire instantly, like flipper switches and the switches attached to automatically fired coils like slingshots and pop bumpers.

Switch Concepts

- [*Switch Debounce Theory*](#)
- [*Switch Controller*](#)

Monitorable Properties

For *dynamic values* and *conditional events*, the prefix for switches is `device.switches.<name>`.

state Numeric value which represents the logic state of this switch. 0 is inactive, 1 is active.

recycle_jitter_count How many times this switch has activated within it's configured `ignore_window_ms:`. (These activations are ignored.)

Related How To guides

- *Tutorial step 3: Get flipping!*
- *How to configure opto switches*

Related Events

- *switch_(name)_active*
- *switch_(name)_inactive*
- *sw_(tag_name)*

Switch Debounce Theory

There's a lot of confusion around how "debounce" works in pinball machines and in MPF, mainly because different hardware platforms do things in very different ways. So this tech note will explain the different ways that debounce works, how MPF deals with it, and the technical back stories.

Understanding debounce

On the surface, switch *debounce* is pretty straightforward. Switches are mechanical things, computers are fast, and your pinball software wants to make sure a switch is actually in a new state before acting on a switch.

Pinball controllers set debounce in different ways. For example, some platforms (P-ROC, P3-ROC) say "a switch must be in a new state for 2 consecutive reads" to be considered debounced, while other platforms (FAST) focus on time-based durations rather than number of reads, saying, "a switch must be in a new state for X milliseconds before it's considered debounced."

When discussing debounce, a lot of people tend to fixate on how "long" the debounce is (10ms, 30ms, etc.), and conversations devolve into arguments about switch lag and human perception, the "feel" of "instant", etc.

But the "lag" of a switch response is only part of the conversation about debounce times.

The other important thing is if you set your debounce times too long, then you risk switch events being missed. (It would be annoying if a ball brushed a pop bumper and the bumper not didn't fire.)

If you set your debounces too short, you risk getting multiple switch events for what should have been a single switch event. (Again it would be annoying if a ball hit a pop bumper and that bumper fired once, but you actually got back multiple switch events which led to multiple scores, multiple sound effects, etc.)

Understanding switch scanning loop speed

The other major factor which affects debounce involves the timing of how the switches are read.

In all modern pinball platforms, a switch changing state doesn't interrupt the controller. Instead, the controller reads the state of all switches at a certain interval.

But even this varies from platform-to-platform, and even based on whether you have matrix or direct switches. (More on this in a bit.)

The important thing, though, is that different controllers and different types of switches are checked at different intervals. That could be every millisecond, or every 2ms, or every 8ms. . . really it's up to the controller and switch type as they're all different.

Debounce + switch scanning loop speed = confusion!

Now combine the two previous concepts, and you quickly see we have some complex scenarios about how “debounce” *really* works.

For example, let's start with a switch on a platform that defines debounce as two consecutive reads of the same state. How does that translate into real-world time? In other words, how long does that switch need to be active before the controller considers it to be active?

We can't answer that question until we understand the switch scanning loop speed.

For example, if the controller hardware steps through each switch poll at 1ms intervals, that means it polls the direct switches, then 1ms later is polls column 1, then 1ms, column 2, 1ms, column 3, etc.

So in the case of an 8x8 matrix with a single bank of direct switches, the status of each switch is polled every 9ms.

Now imagine you have a switch configured for no debounce. How long does that switch have to be in the new state to be considered changed?

If the switch changes state at the exact perfect instant that its column is being read, then the active time for that switch is essentially instant.

However, if that switch's column is read, then 1ms later that switch goes active, then 7ms after that the switch goes inactive again—all that happened within the 9ms polling “gap”.

In other words, you could have a switch which was technically active for 7ms, but the pinball controller completely missed it!

Same for debouncing. If debouncing needs a switch to be in the active state for two consecutive reads to be considered active, and the switch polling loop only poll that switch's column, then you could actually have a switch that was active for 17ms (1ms less than 9ms * 2 reads), and the switch would not be seen as active!

So, again using a 9ms polling loop as an example:

Type	Min time to activate	Max time that still might not activate
Debounced	10ms	17ms
Not Debounced	1ms	7ms

Matrix versus direct switches

These longer loop times between switch reads are a necessity when switch matrices are used. After all, you can only step through the matrix so fast before running into FCC issues.

In theory, “direct” switches could mean the switches could be polled more often. However, just because a switch is called a “direct” switch doesn't automatically mean that it's polled more often.

For example, on the P-ROC, the direct switches are essentially like an extra 1x8 switch matrix where the “column” is always active. But the reads of the direct switches are slotted into the timing of the

reads of the matrix switches, meaning P-ROC direct switches are not read any faster or more often than matrix switches.

(The P3-ROC uses SW-16 switch boards with 2 banks of direct switches each. I'm awaiting confirmation to see how the timing works on those.)

FAST hardware switches connected to FAST I/O boards are direct as well. However since each I/O board has its own processor on it, those switches are polled every 1ms.

(When FAST releases a switch matrix daughter board, those columns will need to be strobed 1-by-1, meaning FAST matrix switches will have longer polling intervals than FAST direct switches.)

Putting it all together

The P-ROC hardware allows for two debounce settings: *on* and *off*. Debounce *on* means the switch must be in the same state for two consecutive reads before the switch change event is sent to the host, and debounce *off* means the switch event will be sent to the host as soon as it changes.

The polling interval on the P-ROC is configurable, and you also need to take into consideration how big your matrix is (do you have 8 or 9 columns), how many direct switches you have, etc.

FAST hardware accepts debounce settings based on milliseconds, e.g. "How many ms does a switch have to be in the new state before a change event is sent to the host?"

Putting it all together this means that on a P-ROC, *debounce off* is not the same thing as *debounce 0* on a FAST controller.

Depending on your hardware, *debounce off* on a P-ROC could still mean it takes 7ms (or more) for a switch to register, and *debounce on* on a P-ROC means that it could take 17ms (or more) for a switch to register.

So if you have a FAST controller with a direct switch connected to a FAST I/O board, setting (for example) *debounce 5ms* does *not* mean the FAST controller is going to be "slower" to respond than a P-ROC that's set to *debounce off*.

This also shows why the recommendation in the P-ROC community has historically been to set *debounce off* on autofire rules, since *debounce on* would mean a switch could potentially have to be activated for 17ms (or more, again, depending on the size of the matrix and other things). It's also why FAST has been recommending 10ms for "instant" response and 30ms for "regular" switches. (Which, if you don't like 10ms/30ms, you could change to 7ms/20ms, or whatever you want.)

The point is that FAST's 10ms/30ms isn't actually that different than P-ROC's off/on settings when you actually dig under the hood and see how the timing works.

Switch Controller

The *Switch Controller* is responsible for receiving all hardware switch state changes and translating them into MPF events which are broadcast out to all the other game modules. In other words, the switch controller is the only part of the game that actually receives notification of the physical switches—it's the only thing that "talks to" the switch hardware. Everything else in the game just waits for the switch controller to tell it that a switch action happened, rather than all different parts of the game all talking to hardware.

Why do we force everything to talk to the switch controller instead of letting individual modules talk to the switches directly? Lots of reasons:

- The switch controller has the intelligence to know whether a switch is normally open (NO) or normally closed (NC), based on how each switch is configured in the machine configuration files. This means that all the game modules only have to listen for the *switch active* and *switch inactive* events, rather than each module needing the intelligence to transpose the switch states as needed.
- The switch controller can change the timing of switches, even applying software delays and debouncing to switches, and this is all hidden from the other MPF modules.
- The switch controller can “hide” physical switch activities from the game. This is most useful for broken switches that are firing like crazy. If the switch controller notices that a switch is going nuts, it can suppress those events, slow them down, or just ignore them altogether. That way you can just write your game code to say something like “when this switch is active, assign these points” and you don’t have to worry about a bad switch giving all your players high scores! (This functionality is not yet complete)
- The switch controller can also reprogram the game logic around broken switches. So if it knows that a switch is broken, it can send the game switch events for the broken switch when some alternate switch is hit. This means that each of your game modules can automatically get the benefit of this intelligent switch substitution without you having to write anything special. (Again, how this substitution takes place and which switches can be substituted for others is all configurable in your config files.)
- Since the switch controller is the only interface into the game for switches, it can “inject” switch events from any source. For example, MPF includes functionality to simulate switch events with a computer keyboard (for testing and debugging), as well as switch events from a mobile phone or tablet (via the OSC plug-in). We also have a plug-in to read and playback switch events from log files from games that already ran, as well as the ability to write scripts that simulate games. All this is done by interfacing to the switch controller—your actual game code doesn’t know (or care) where the original switch events came from.

How to configure opto switches

todo

Targets

Related Config File Sections
<i>drop_targets:</i>
<i>drop_target_banks:</i>
TODO add the rest

There are many types of targets on a pinball playfield some of which are described here. In the Mission Pinball Framework(MPF) they are handled in a number of ways depending. In some instances they are just a switch hit while in others they may require a coil to be fired to reset or fire the ball back at the player.

Related How To Guides
TODO

Related Events
<i>drop_target_(name)_down</i>
<i>drop_target_(name)_up</i>
<i>drop_target_bank_(name)_down</i>
<i>drop_target_bank_(name)_mixed</i>
<i>drop_target_bank_(name)_up</i>

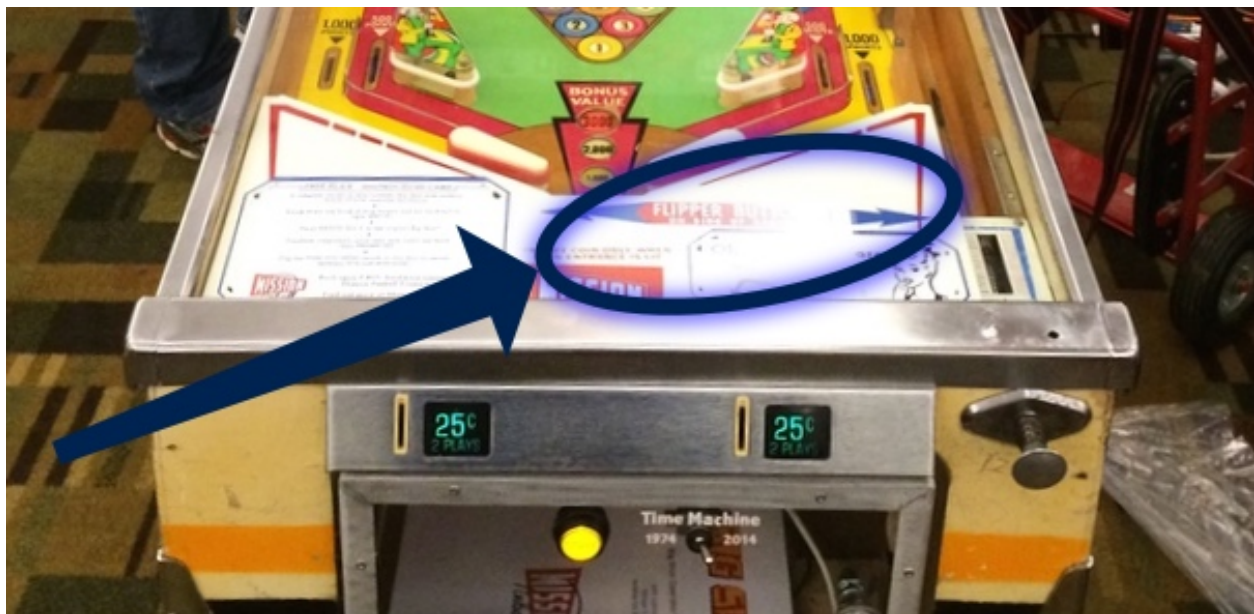
Troughs / Ball Drains

Related Config File Sections
<i>ball_devices:</i>

Every pinball machine will have some kind of ball trough / drain device. This is the place where the balls go when they drain from the playfield before they're ejected into the plunger lane.

In many cases, this device (or series of devices) holds multiple balls and is the location where unused balls are stored.

There are several different designs for troughs and drains that have been used over the past 70 years, and (as far as we know), MPF supports all of them. So regardless of what's in your machine, we're talking about whatever is under here:



Here are the options:

- *Modern trough with opto sensors*
- *Modern trough with mechanical switches*
- *Older style with two coils and switches for each ball*
- *Older style with two coils and only one ball switch*
- *Classic single ball, single coil*

Since there are so many different options, you need to first identify which type of trough or ball drain system your machine has. So look at the following pictures to match up what you have, and then follow the specific links to see how to configure MPF to use it in your machine.

Option 1: Modern trough with opto sensors

Modern-style troughs (which have been used since about 1993 or so) are mostly located underneath the playfield and hold the balls at an incline so they roll down to the end. There is a single coil which fires to eject a ball up and out where it's directed to the plunger lane.

Todo: We need to add a photo of this type of trough.

The advantage of modern troughs are (1) the balls entering are gravity-fed, meaning they only need one coil, and (2) they can hold a lot of balls. (Most hold 4-6 balls but you can buy ones that hold up to 8.)

If you have a modern-style trough with a circuit board on each side, that means your trough uses opto sensors to detect the presence of a ball. One of those circuit boards contains infrared LEDs which are always on which shoot invisible beams across the ball paths, and the board has sensors that detect if a light beam is broken, meaning a ball is sitting there blocking the path.

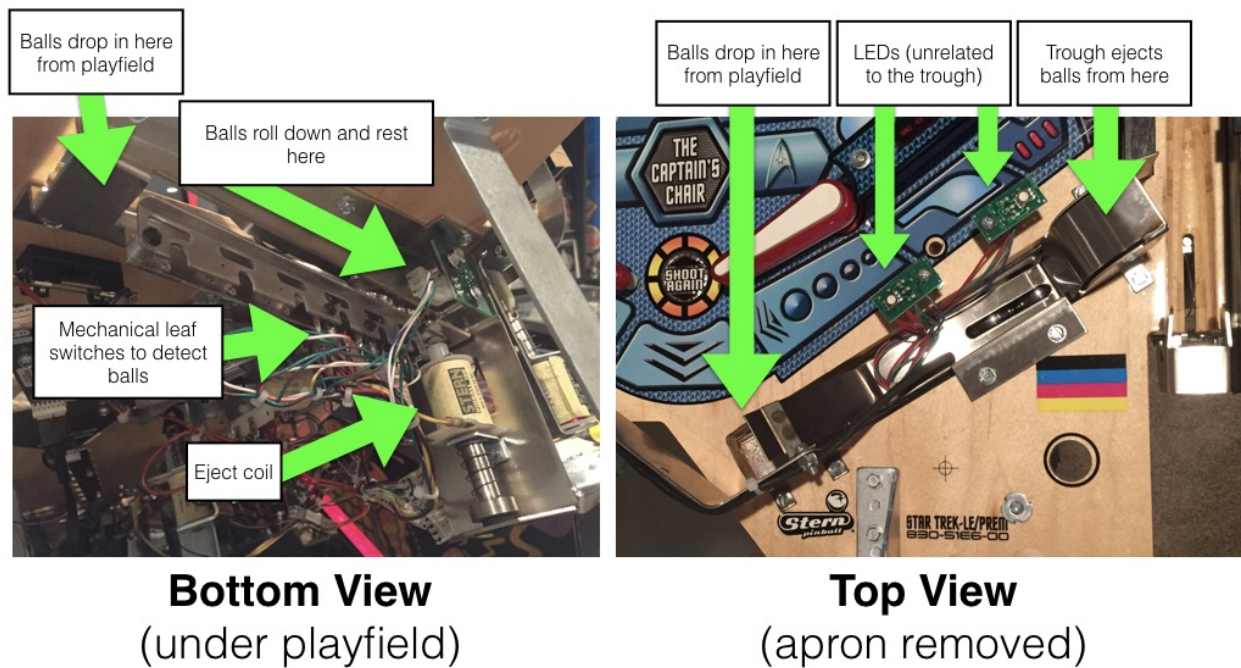
Common parts include:

- Williams: A-16809
- Mantis Trough

If you have a modern trough with opto sensors, read the [How to configure a modern trough with opto switches](#) guide to continue.

Option 2: Modern trough with mechanical switches

Some modern-style troughs use mechanical switches to detect the balls rather than infrared opto boards. (Other than that, they're the same as the opto-based troughs.) Here's a photo of a modern trough with mechanical switches from a Stern Star Trek Premium machine:



If you have a modern-style trough with mechanical switches instead of opto boards, then read the [How to configure a modern trough with mechanical switches](#) guide to continue.

Common parts include:

- Stern: 500-6318-24 (trough assembly), 535-8393-00 (center drain ball guide), 535-7329-01 (entry/exit scoop)
- Pinball Life/Spooky: PBL-100-0015-00 (4 balls) or PBL-100-0016-00 (8 balls), PBL-100-0002-00 (drain guide + enter exit scoop)

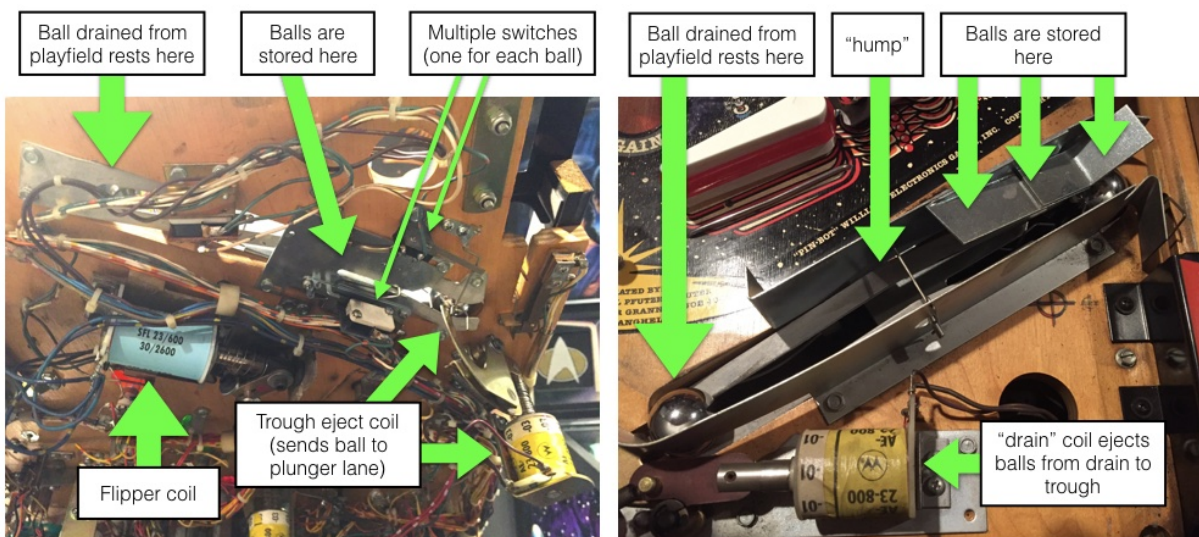
Option 3: Older style with two coils and switches for each ball

Many machines from the 1980s and early 1990s have a ball trough system that consists of two separate coils and where the balls stay “on top” of the playfield (under the apron).

In this case, when a ball drains, a coil in the drain area pulses to eject the ball up over a hump where the balls are stored. Then a second coil near the plunger lane is used to eject a single ball at a time into the plunger lane.

Some of these types “two coil” systems have multiple switches on the side that stores the balls, with there being one switch for each ball. That lets the machine know exactly how many balls are sitting there because each ball is sitting on a switch.

Here’s a photo of this type of trough system from a Pin*Bot machine:



Bottom View
(under playfield)

Top View
(apron removed)

If you have this kind of trough system, read the [How to configure an older style trough with two coils and switches for each ball](#) guide to continue.

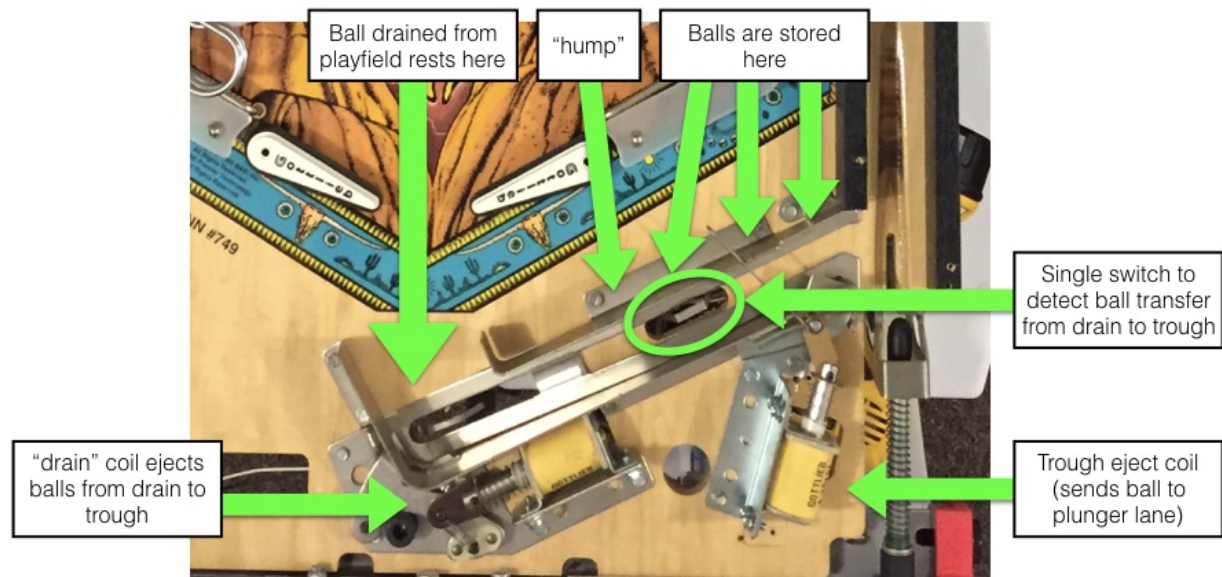
Option 4: Older style with two coils and only one ball switch

Another option is similar to Option 3 above, except there's only one switch on the trough side instead of separate switches for each ball. In these types of trough systems, the behavior of that switch changes depending on how many balls are in the trough.

If there are fewer than the max number of balls in the trough, when the drain coil pulses to eject the ball from the drain into the trough, the ball will roll over that trough switch, meaning it's activated momentarily and then deactivated again.

However, if the ball ejecting into the trough will be the final ball that will fill the trough, then that ball will rest on that trough switch, meaning that switch is solid active as long as the trough is full.

Here's a photo from a Gottlieb System 3 machine (Brooks 'n Dunn) which shows what this type of system looks like:



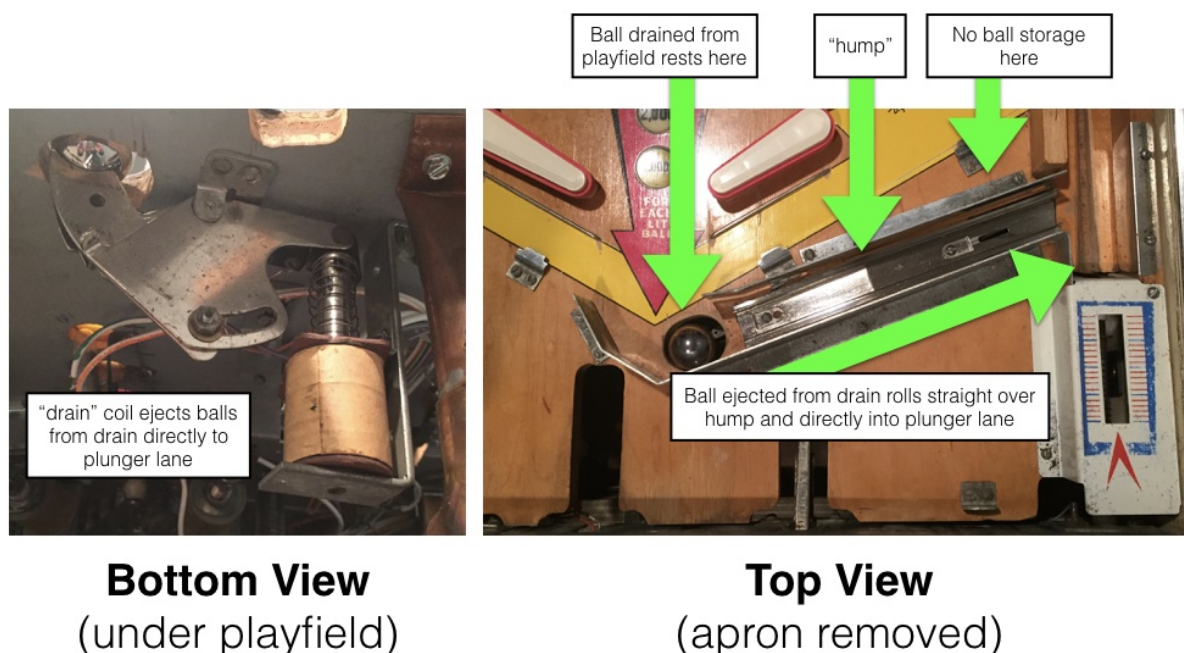
Top View
(apron removed)

If your machine has a system similar to this, then read the [How to configure an older style trough with two coils and only one ball switch](#) guide to continue.

Option 5: Classic single ball, single coil

Older single-ball machines have a trough system that is on top of the playfield under the apron, but they only have a single coil near the ball drain position. The ball is stored in the drain area, and when it needs to be ejected, a coil pulses to eject it from the drain all the way into the plunger lane in a single action.

Here's an example from Gottlieb Big Shot:



If you have a system like this, read the [How to configure a classic single-ball trough](#) guide to continue.

Option 6: Something we haven't seen yet

If you're using MPF with a machine that has some kind of trough or drain system that we haven't covered here, we would like to know about it so we can write a how to guide and/or add support for it in MPF.

As far as we know, however, these 5 options should cover everything. For example, you might have a machine that you think is different, but when you really look at it, it's just a weird form of one of these 5 options. (Bally Fathom is a great example of this. It's like a classic single-ball trough where there is a drain that ejects a ball all the way into the plunger lane, but there are two additional switches in the apron wall where balls rest before they land in the drain device. That style of drain and trough is actually configured using Option 2, the modern trough with mechanical switches.)

If you have something weird that you can't figure out, we're happy to help! Just post a photo of it to [MPF Users Google Group](#) and we'll go from there.

Related How To Guides

[Tutorial step 7: Add your trough](#)

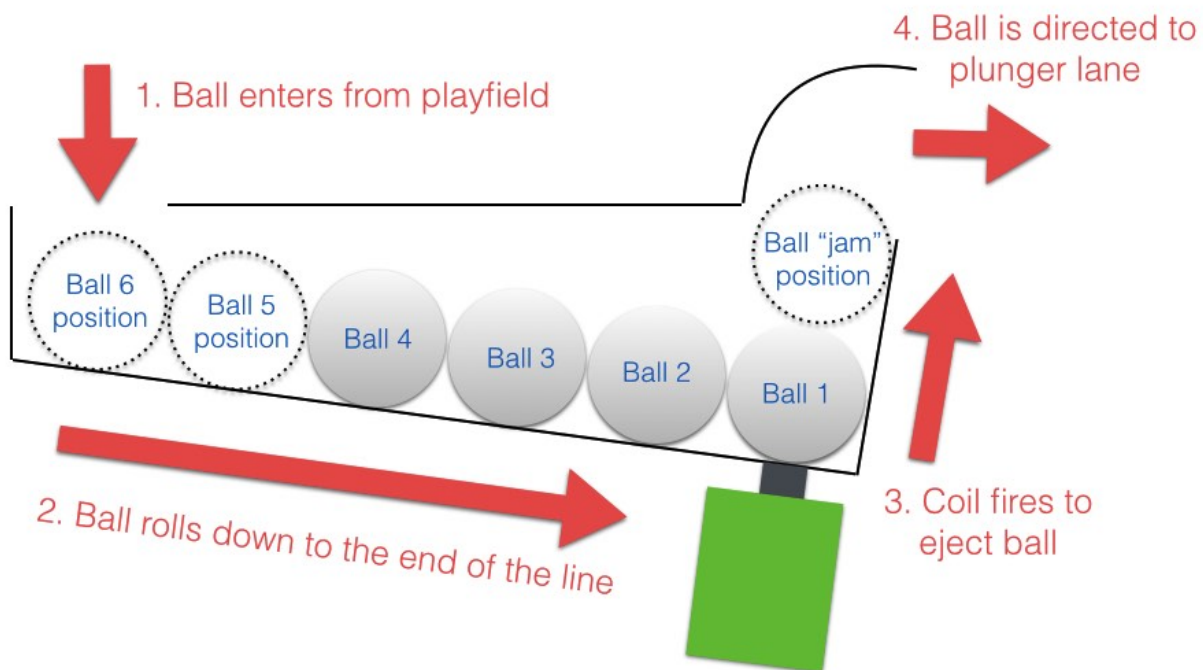
Related Events
<i>ball_drain</i>
<i>balldevice_ball_missing</i>
<i>balldevice_balls_available</i>
<i>balldevice_(balls)_ball_missing.</i>
<i>balldevice_captured_from_(device)</i>
<i>balldevice_(name)_ball_eject_attempt</i>
<i>balldevice_(name)_ball_eject_failed</i>
<i>balldevice_(name)_ball_eject_success</i>
<i>balldevice_(name)_ejecting_ball</i>

How to configure a modern trough with opto switches

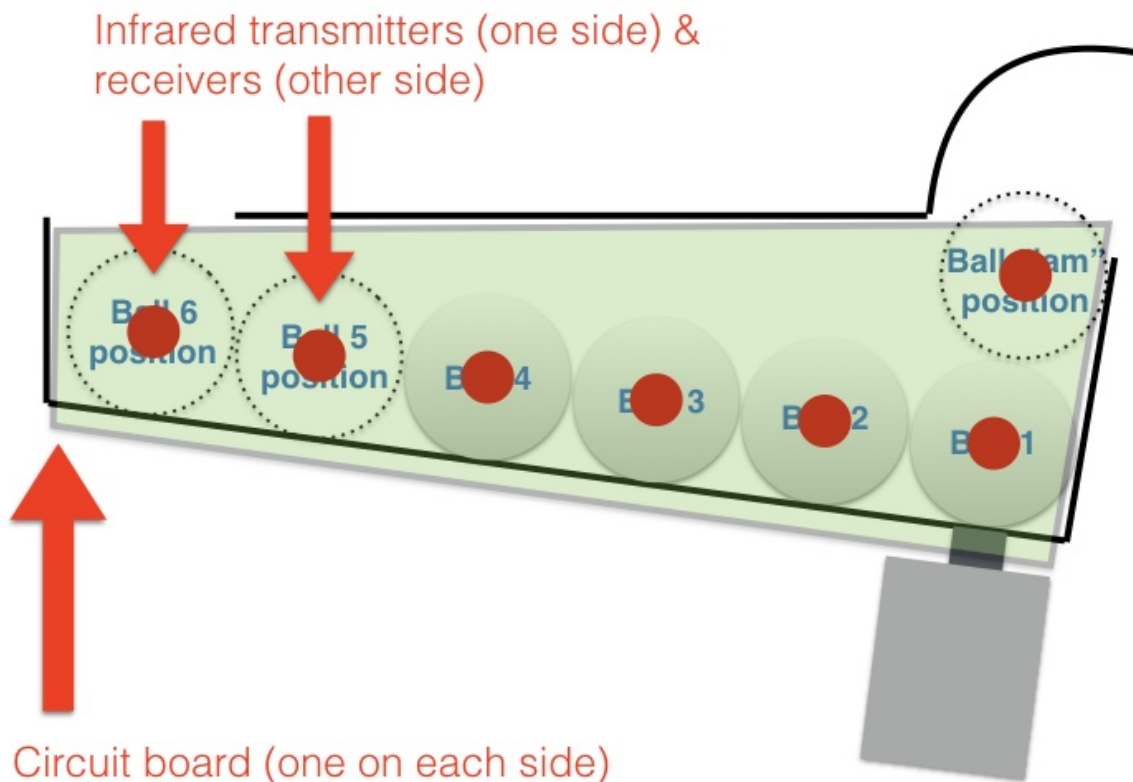
This guide will show you how to configure MPF to use a modern-style trough with opto boards. (If you have a modern-style trough which uses mechanical leaf switches, use [this guide](#) instead.)

Todo: We need to add a photo of this type of trough.

The following diagram shows how the ball flow and eject coil work in a modern trough. (This is a side view)



And this diagram shows how the “opto boards” are typically located. Note that one of the opto boards is a “transmit” board that contains infrared LEDs which are always on, and the other side is the “receive” board which contains photo transistors which are activated when the IR beam is hitting them (i.e. when there is no ball blocking the path) and inactive when a ball is present and in the way.



1. Add your trough switches

The first step is to add your trough's switches to the switches: section of your machine config file. Create an entry in the switches: section for each switch in your trough, like this: (This example has six switches plus the jam switch. Yours may have more or less.)

```
switches:
  s_trough1:
    number: 02
    type: NC
  s_trough2:
    number: 03
    type: NC
  s_trough3:
    number: 04
    type: NC
  s_trough4:
    number: 05
    type: NC
  s_trough5:
    number: 06
    type: NC
  s_trough6:
    number: 07
    type: NC
  s_trough_jam:
```



```
number: 08
type: NC
```

Note that we configured this switches with numbers 02 through 08, but you should use the actual switch numbers for your control system that the trough optos are connected to. (See [How to configure “number:” settings](#) for instructions for each type of control system.)

It makes no difference which switch is which (in terms of whether Switch 1 is on the left side or the right side). Also the actual switch names don’t really matter. We use `s_trough1` through `s_trough6` plus `s_trough_jam`, though you can call them `s_ball_trough_1` or `trough_ball_1` or `s_mr_potatohead`.

Note: The “jam” switch position is the switch which detects if a ball is sitting on top of the lowest ball. We think all modern opto troughs have optos to detect the jams, but if yours doesn’t, that’s fine—just don’t enter it. (If you have it though you definitely want to use it because it makes MPF smarter about how it handles balls that get stacked.)

2. Add your trough eject coil

Next, create an entry in your `coils:` section for your trough’s eject coil. Again, the name doesn’t matter. We’ll call this `c_trough_eject` and enter it like this:

```
coils:
  c_trough_eject:
    number: 04
    pulse_ms: 20
```

Again, the `number:` entries in your config will vary depending on your actual hardware, and again, you can pick whatever name you want for your coil.

You’ll also note that we went ahead and entered a `pulse_ms:` value of 20 which will override the default pulse time of 10ms. It’s hard to say at this point what value you’ll actually need. You can always adjust this at any time. You can play with the exact values in a bit once we finish getting everything set up.

3. Add your “trough” ball device

In MPF, the trough is a [ball device](#), so you’ll add a configuration for it to the `ball_devices:` section of your machine config. (If you don’t have that section add it now.)

Then in your `ball_devices:` section, create an entry called `bd_trough:`, like this:

```
ball_devices:
  bd_trough:
```

This means that you’re creating a ball device called `bd_trough`. We use the preface `bd_` to indicate that this is a ball device which makes it easier when we’re referencing them later. Then under your `bd_trough:` entry, start entering the configuration settings for your trough ball device:

3a. Add your trough switches to your trough ball device

Indented under `bd_trough:`, create an entry called `ball_switches:` and then add a comma-separated list of all the switches in your trough, like this:

```
ball_switches: s_trough1, s_trough2, s_trough3, s_trough4, s_trough5, s_trough6, s_trough_jam
```

So this is eight spaces, followed by the word “`ball_switches`”, then a colon, then a space, then the name of your first switch, comma, then your second switch, comma, etc. . .

Again these switches can be in any order. The key is that you’re entering one switch for each position that’s used to detect whether a ball is in the trough at that position.

If you have the opto in the jam position, enter it in this list too, since a ball sitting on top of another one still “counts” as a ball in the trough.

The number of switches you enter here will tell MPF how many balls your trough can hold. When MPF wants to know how many balls are in the trough, it will check all these switches to see which ones are active, and the total number active represents how many balls it’s holding at that moment.

3b. Add your eject coil to your trough ball device

Next create a setting called `eject_coil:` which will be the name of the coil that MPF should fire when it wants to eject a ball from the trough. This should be the name of the coil you added in Step 2, `c_trough_eject` in our case:

```
eject_coil: c_trough_eject
```

Note that MPF will simply pulse the eject coil at its default pulse time when it wants to eject a ball from the trough.

3c. Add some tags to tell MPF about this device

The final configuration setting you need to enter for your trough is a list of tags which tell MPF certain things about this device.

Tags are just a comma-separated list of words you add to the `tags:` setting for a device. Ball devices can use some special tag names that tell MPF how it should use it.

First, add a tag called `trough` which tells MPF that a ball device wants to hold as many balls as it can. This probably doesn’t make sense right now, which is fine, but without this tag then MPF won’t know what to do with all the balls that are sitting in the trough waiting to be launched. This tag tells MPF that it’s fine for this device to hold lots of balls.

Next, add a tag called `home` which tells MPF that any balls in this device are considered to be in their “home” positions. When MPF first starts up, and after a game ends, it will automatically eject any balls from any devices that are not tagged with “home.” When a player tries to start a game, MPF will also make sure all the balls in the machine are contained in devices tagged with “home.”

Finally, you need to add a tag called `drain` which is used to tell MPF that a ball entering this device means that a live ball has drained from the playfield. At this point you might be wondering why you have to enter all three of these tags. Why can’t the simple `trough` tag be enough to tell MPF that a ball entering it should trigger a drain and that balls are home? This is due to the flexibility of MPF and the nearly unlimited variations of pinball machine hardware in the world. Some machines have multiple

troughs. Some machines have drain devices which aren't troughs. Some machines consider balls outside the trough to be home. So even though these all might seem similar, just know that for now you have to add trough, home, and drain tags to your trough. You can specify the tags in any order, and your tags: entry should look something like this:

```
tags: trough, home, drain
```

3d. Add & configure your jam switch

If you have a jam switch, add a setting called `jam_switch`: and add it there, like this:

```
jam_switch: s_trough_jam
```

You can also configure an eject pulse time (in ms) that will be used when the trough wants to eject a ball but the jam switch is active. You'll have to play with your actual trough to see what this time should be. In most cases it's actually *less* time than the regular eject pulse time, because in most cases, the regular pulse time will kick out two balls (the jammed ball and the one below it).

So for our example, we'll set the jam pulse time to 15ms.

```
eject_coil_jam_pulse: 15ms
```

(Note that this setting is a time string, so you can include the "ms" in the setting value.)

4. Configure your virtual hardware to start with balls in the trough

While we're talking about the trough, it's probably a good idea to configure MPF so that when you start it in virtual mode (with no physical hardware) that it starts with the trough full of balls. To do this, add a new section to your config file called `virtual_platform_start_active_switches:`. (Sorry this entry name is hilariously long.) As its name implies, *virtual_platform_start_active_switches*: lets you list the names of switches that you want to start in the "active" state when you're running MPF with the virtual platform interfaces.

The reason these only work with the virtual platforms is because if you're running MPF while connected to a physical pinball machine, it doesn't really make sense to tell MPF which switches are active since MPF can read the actual switches from the physical machine. So you can add this section to your config file, but MPF only reads this section when you're running with one of the virtual hardware interfaces. To use it, simply add the section along with a list of the switches you want to start active. For example:

```
virtual_platform_start_active_switches:
    s_trough1
    s_trough2
    s_trough3
    s_trough4
    s_trough5
    s_trough6
```


5. Add your plunger lane

Remember that ball devices in MPF know what their “target” devices are, meaning that they understand the chain of devices the ball path takes. (For example, the trough ejects to the plunger lane which ejects to the playfield which drains to the trough. . .)

So in order to completely configure your trough, you need to tell it the name of the devices that it ejects to. For the purposes of this How To guide, we’ll just create a placeholder plunger lane called *bd_plunger*, though you should see the [Plungers & Ball Launch Devices](#) documentation for full details since there are lots of different types of plungers.

You add an eject target via the `eject_targets:` section, like this:

```
eject_targets: bd_plunger
```

Of course you should enter the name of your actual plunger lane / ball launcher device.

Note that the `eject_targets:` entry is “targets” (plural), but in this case we’re only adding a single target. That’s fine and how you would configure a trough since it only ejects to one place (the plunger lane). Some devices eject to pathways with diverters which can direct the ball to multiple different places, so that’s the scenario where you’d enter more than one target. But for the trough, it’s just the one.

Here’s the complete config

```
#config_version=4

switches:
  s_trough1:
    number: 02
    type: NC
  s_trough2:
    number: 03
    type: NC
  s_trough3:
    number: 04
    type: NC
  s_trough4:
    number: 05
    type: NC
  s_trough5:
    number: 06
    type: NC
  s_trough6:
    number: 07
    type: NC
  s_trough_jam:
    number: 08
    type: NC

coils:
  c_trough_eject:
    number: 04
    pulse_ms: 20
```



```

ball_devices:
  bd_trough:
    ball_switches: s_trough1, s_trough2, s_trough3, s_trough4, s_trough5, s_trough6, s_trough_jam
    eject_coil: c_trough_eject
    tags: trough, home, drain
    jam_switch: s_trough_jam
    eject_coil_jam_pulse: 15ms
    eject_targets: bd_plunger

    # bd_plunger is a placeholder just so the trough's eject_targets are valid
  bd_plunger:
    tags: ball_add_live
    mechanical_eject: true

virtual_platform_start_active_switches:
  s_trough1
  s_trough2
  s_trough3
  s_trough4
  s_trough5
  s_trough6

```

What if it doesn't work?

If you've gotten this far and your trough isn't working right, there are a few things you can try (depending on what your problem is).

First, add a debug: true entry into your trough config in the ball_devices: section. Then when you run with verbose logging (-v), you'll get extra debugging information in the log.

If your log file shows a number of balls contained in your trough that doesn't match how many balls you actually have, that could be:

- You didn't add all the ball switches to the *ball_switches:* section of the trough configuration
- You're using a physical machine but a switch isn't adjusted properly so the ball is not actually activating it. (Seriously, we can't tell you how many times that's happened! We've also found that on some machines, if you only have one ball in the trough that the single ball isn't heavy enough to roll over the top of the eject coil shaft. In that case we just add a few more balls to the machine and it seems to take care of it.) Either way, if you have a ball in the trough, the switch entry in your log should show that the switch is active (*State:1*), like this:

```
2014-10-27 20:05:29,891 : SwitchController : <<<<< switch: trough1, State:1 >>>>>
```

If you see State:1 immediately followed by another entry with State:0, that means the ball isn't activating the switch even though it might be in the trough.

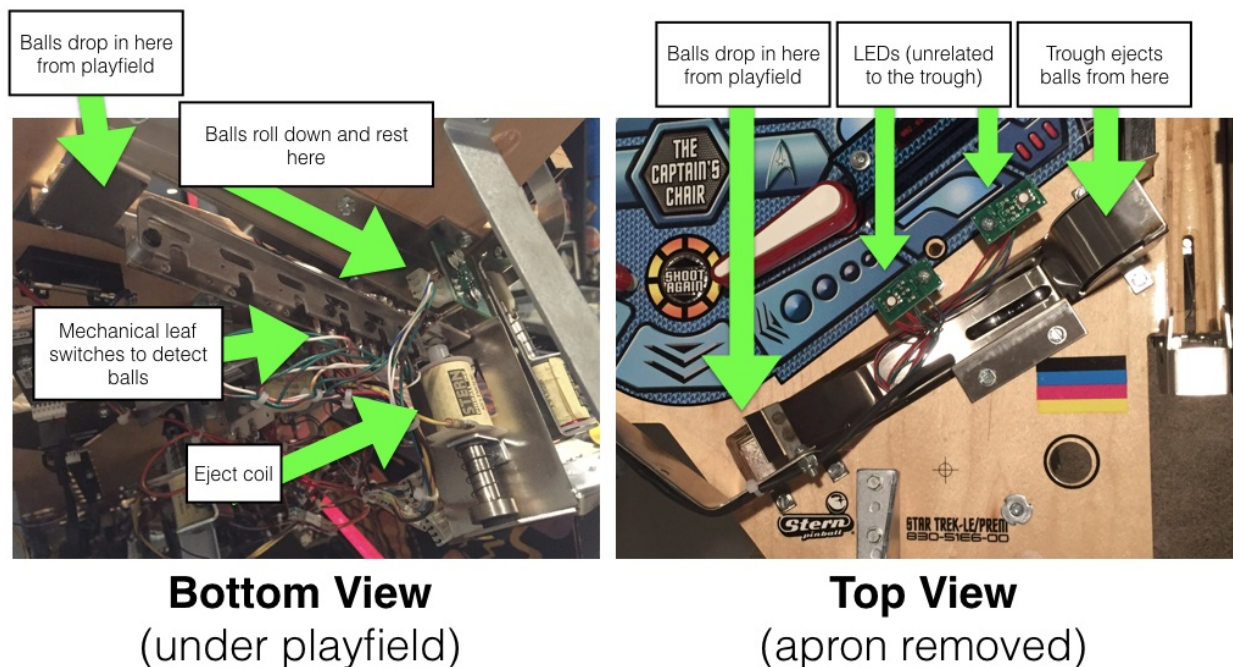
If you get a YAML error, a "KeyError", or some other weird MPF error, make sure that all the switch and coil names you added to your trough configuration exactly match the switch and coil names in the switches: and coils: sections of your config file.

Also make sure that all your names are allowable names, meaning they are only letters, numbers, and the underscore, and that none of your names start with a number.

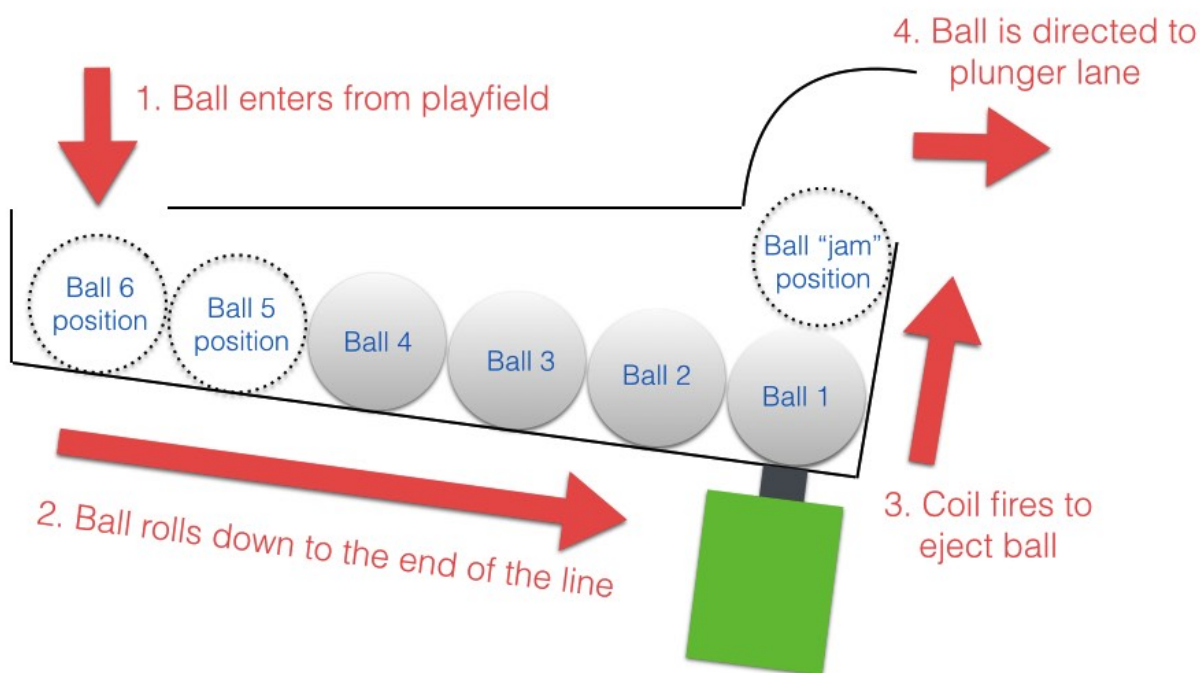
How to configure a modern trough with mechanical switches

This guide will show you how to configure MPF to use a modern-style trough which uses mechanical leaf switches. If you have a modern trough that uses opto boards, use [this guide](#) instead.

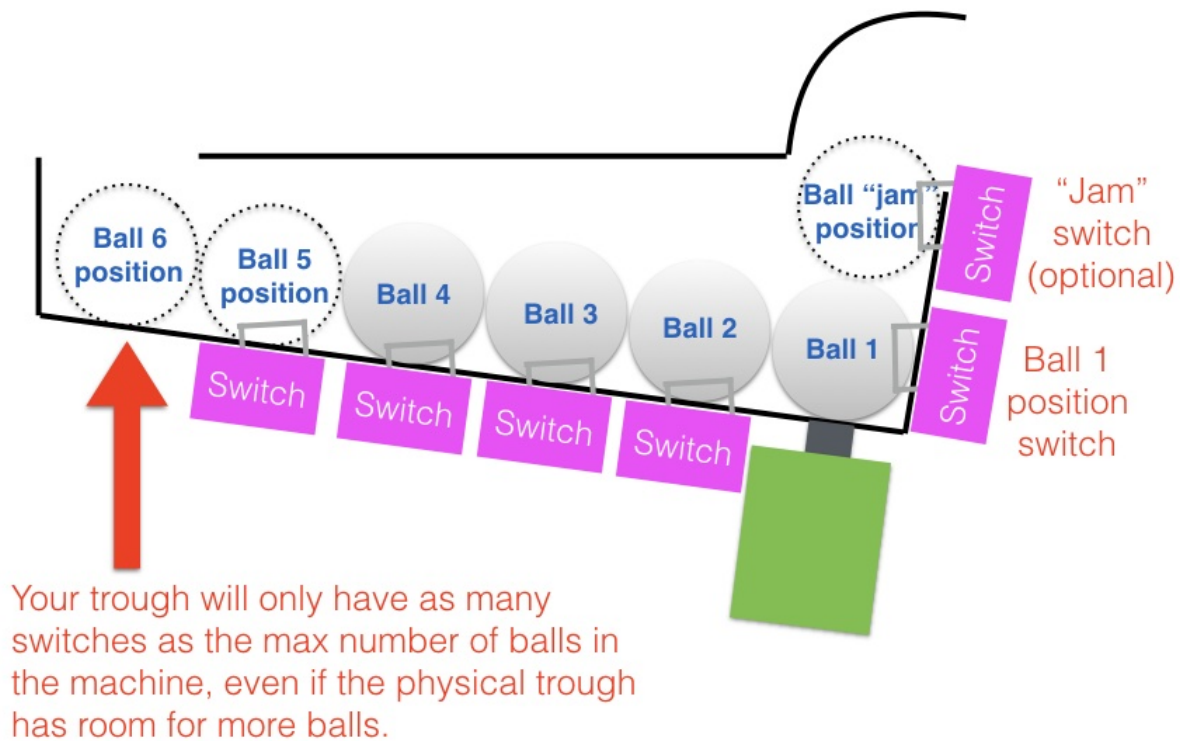
Here's an example from a Stern Star Trek Premium machine:



The following diagram shows how the ball flow and eject coil work in a modern trough. (This is a side view)



And this diagram shows how the switches are typically arranged in a modern trough with mechanical switches:



Note: Not all modern troughs have the “jam” switch, and depending on how many balls were designed to go in your machine, it’s possible that not all the ball switches are populated. (Though you can add more to increase the number of balls in your machine!)

1. Add your trough switches

The first step is to add your trough’s switches to the switches: section of your config file. Create an entry in your switches: section for each switch in your trough, like this: (This example has six switches plus the jam switch. Yours may have more or less.)

```
switches:
  s_trough1:
    number: 02
  s_trough2:
    number: 03
  s_trough3:
    number: 04
  s_trough4:
    number: 05
  s_trough5:
    number: 06
  s_trough6:
```



```

    number: 07
s_trough_jam:
    number: 08

```

Note that we configured this switches with numbers 02 through 08, but you should use the actual switch numbers for your control system that the trough switches are connected to. (See [How to configure “number:” settings](#) for instructions for each type of control system.)

It makes no difference which switch is which (in terms of whether Switch 1 is on the left side or the right side). Also the actual switch names don’t really matter. We use `s_trough1` through `s_trough6` plus `s_trough_jam`, though you can call them `s_ball_trough_1` or `trough_ball_1` or `s_mr_potatohead`.

Note: The “jam” switch position is the switch which detects if a ball is sitting on top of the lowest ball. Not all troughs have this, so if yours doesn’t, that’s fine—just don’t enter it. (If you have it though you definitely want to use it because it makes MPF smarter about how it handles balls that get stacked.)

2. Add your trough eject coil

Next, create an entry in your `coils:` section for your trough’s eject coil. Again, the name doesn’t matter. We’ll call this `c_trough_eject` and enter it like this:

```

coils:
    c_trough_eject:
        number: 04
        pulse_ms: 20

```

Again, the `number:` entries in your config will vary depending on your actual hardware, and again, you can pick whatever name you want for your coil.

You’ll also note that we went ahead and entered a `pulse_ms:` value of 20 which will override the default pulse time of 10ms. It’s hard to say at this point what value you’ll actually need. You can always adjust this at any time. You can play with the exact values in a bit once we finish getting everything set up.

3. Add your “trough” ball device

In MPF, the trough is a [ball device](#), so you’ll add a configuration for it to the `ball_devices:` section of your machine config. (If you don’t have that section add it now.)

Then in your `ball_devices:` section, create an entry called `bd_trough:`, like this:

```

ball_devices:
    bd_trough:

```

This means that you’re creating a ball device called `bd_trough`. We use the preface `bd_` to indicate that this is a ball device which makes it easier when we’re referencing them later. Then under your `bd_trough:` entry, start entering the configuration settings for your trough ball device:

3a. Add your trough switches to your trough ball device

Indented under `bd_trough:`, create an entry called `ball_switches:` and then add a comma-separated list of all the switches in your trough, like this:

```
ball_switches: s_trough1, s_trough2, s_trough3, s_trough4, s_trough5, s_trough6, s_trough_jam
```

So this is eight spaces, followed by the word “ball_switches”, then a colon, then a space, then the name of your first switch, comma, then your second switch, comma, etc. . .

Again these switches can be in any order. The key is that you’re entering one switch for each position that’s used to detect whether a ball is in the trough at that position.

If you have the switch in the jam position, enter it in this list too, since a ball sitting on top of another one still “counts” as a ball in the trough.

The number of switches you enter here will tell MPF how many balls your trough can hold. When MPF wants to know how many balls are in the trough, it will check all these switches to see which ones are active, and the total number active represents how many balls it’s holding at that moment.

3b. Add your eject coil to your trough ball device

Next create a setting called `eject_coil:` which will be the name of the coil that MPF should fire when it wants to eject a ball from the trough. This should be the name of the coil you added in Step 2, `c_trough_eject` in our case:

```
eject_coil: c_trough_eject
```

Note that MPF will simply pulse the eject coil at its default pulse time when it wants to eject a ball from the trough.

3c. Add some tags to tell MPF about this device

The final configuration setting you need to enter for your trough is a list of tags which tell MPF certain things about this device.

Tags are just a comma-separated list of words you add to the `tags:` setting for a device. Ball devices can use some special tag names that tell MPF how it should use it.

First, add a tag called `trough` which tells MPF that a ball device wants to hold as many balls as it can. This probably doesn’t make sense right now, which is fine, but without this tag then MPF won’t know what to do with all the balls that are sitting in the trough waiting to be launched. This tag tells MPF that it’s fine for this device to hold lots of balls.

Next, add a tag called `home` which tells MPF that any balls in this device are considered to be in their “home” positions. When MPF first starts up, and after a game ends, it will automatically eject any balls from any devices that are not tagged with “home.” When a player tries to start a game, MPF will also make sure all the balls in the machine are contained in devices tagged with “home.”

Finally, you need to add a tag called `drain` which is used to tell MPF that a ball entering this device means that a live ball has drained from the playfield. At this point you might be wondering why you have to enter all three of these tags. Why can’t the simple trough tag be enough to tell MPF that a ball entering it should trigger a drain and that balls are home? This is due to the flexibility of MPF and the nearly unlimited variations of pinball machine hardware in the world. Some machines have multiple

troughs. Some machines have drain devices which aren't troughs. Some machines consider balls outside the trough to be home. So even though these all might seem similar, just know that for now you have to add trough, home, and drain tags to your trough. You can specify the tags in any order, and your tags: entry should look something like this:

```
tags: trough, home, drain
```

3d. Add & configure your jam switch

If you have a jam switch, add a setting called `jam_switch`: and add it there, like this:

```
jam_switch: s_trough_jam
```

You can also configure an eject pulse time (in ms) that will be used when the trough wants to eject a ball but the jam switch is active. You'll have to play with your actual trough to see what this time should be. In most cases it's actually *less* time than the regular eject pulse time, because in most cases, the regular pulse time will kick out two balls (the jammed ball and the one below it).

So for our example, we'll set the jam pulse time to 15ms.

```
eject_coil_jam_pulse: 15ms
```

(Note that this setting is a time string, so you can include the "ms" in the setting value.)

4. Configure your virtual hardware to start with balls in the trough

While we're talking about the trough, it's probably a good idea to configure MPF so that when you start it in virtual mode (with no physical hardware) that it starts with the trough full of balls. To do this, add a new section to your config file called `virtual_platform_start_active_switches:`. (Sorry this entry name is hilariously long.) As its name implies, *virtual_platform_start_active_switches*: lets you list the names of switches that you want to start in the "active" state when you're running MPF with the virtual platform interfaces.

The reason these only work with the virtual platforms is because if you're running MPF while connected to a physical pinball machine, it doesn't really make sense to tell MPF which switches are active since MPF can read the actual switches from the physical machine. So you can add this section to your config file, but MPF only reads this section when you're running with one of the virtual hardware interfaces. To use it, simply add the section along with a list of the switches you want to start active. For example:

```
virtual_platform_start_active_switches:  
    s_trough1  
    s_trough2  
    s_trough3  
    s_trough4  
    s_trough5  
    s_trough6
```


5. Add your plunger lane

Remember that ball devices in MPF know what their “target” devices are, meaning that they understand the chain of devices the ball path takes. (For example, the trough ejects to the plunger lane which ejects to the playfield which drains to the trough. . .)

So in order to completely configure your trough, you need to tell it the name of the devices that it ejects to. For the purposes of this How To guide, we’ll just create a placeholder plunger lane called *bd_plunger*, though you should see the [Plungers & Ball Launch Devices](#) documentation for full details since there are lots of different types of plungers.

You add an eject target via the `eject_targets:` section, like this:

```
eject_targets: bd_plunger
```

Of course you should enter the name of your actual plunger lane / ball launcher device.

Note that the `eject_targets:` entry is “targets” (plural), but in this case we’re only adding a single target. That’s fine and how you would configure a trough since it only ejects to one place (the plunger lane). Some devices eject to pathways with diverters which can direct the ball to multiple different places, so that’s the scenario where you’d enter more than one target. But for the trough, it’s just the one.

Here’s the complete config

```
#config_version=4

switches:
    s_trough1:
        number: 02
    s_trough2:
        number: 03
    s_trough3:
        number: 04
    s_trough4:
        number: 05
    s_trough5:
        number: 06
    s_trough6:
        number: 07
    s_trough_jam:
        number: 08

coils:
    c_trough_eject:
        number: 04
        pulse_ms: 20

ball_devices:
    bd_trough:
        ball_switches: s_trough1, s_trough2, s_trough3, s_trough4, s_trough5, s_trough6, s_trough_jam
        eject_coil: c_trough_eject
        tags: trough, home, drain
        jam_switch: s_trough_jam
```



```

    eject_coil_jam_pulse: 15ms
    eject_targets: bd_plunger

    # bd_plunger is a placeholder just so the trough's eject_targets are valid
    bd_plunger:
        tags: ball_add_live
        mechanical_eject: true

virtual_platform_start_active_switches:
    s_trough1
    s_trough2
    s_trough3
    s_trough4
    s_trough5
    s_trough6

```

What if it doesn't work?

If you've gotten this far and your trough isn't working right, there are a few things you can try (depending on what your problem is).

First, add a debug: true entry into your trough config in the ball_devices: section. Then when you run with verbose logging (-v), you'll get extra debugging information in the log.

If your log file shows a number of balls contained in your trough that doesn't match how many balls you actually have, that could be:

- You didn't add all the ball switches to the *ball_switches:* section of the trough configuration
- You're using a physical machine but a switch isn't adjusted properly so the ball is not actually activating it. (Seriously, we can't tell you how many times that's happened! We've also found that on some machines, if you only have one ball in the trough that the single ball isn't heavy enough to roll over the top of the eject coil shaft. In that case we just add a few more balls to the machine and it seems to take care of it.) Either way, if you have a ball in the trough, the switch entry in your log should show that the switch is active (*State:1*), like this:

```
2014-10-27 20:05:29,891 : SwitchController : <<<< switch: trough1, State:1 >>>>
```

If you see State:1 immediately followed by another entry with State:0, that means the ball isn't activating the switch even though it might be in the trough.

If you get a YAML error, a "KeyError", or some other weird MPF error, make sure that all the switch and coil names you added to your trough configuration exactly match the switch and coil names in the switches: and coils: sections of your config file.

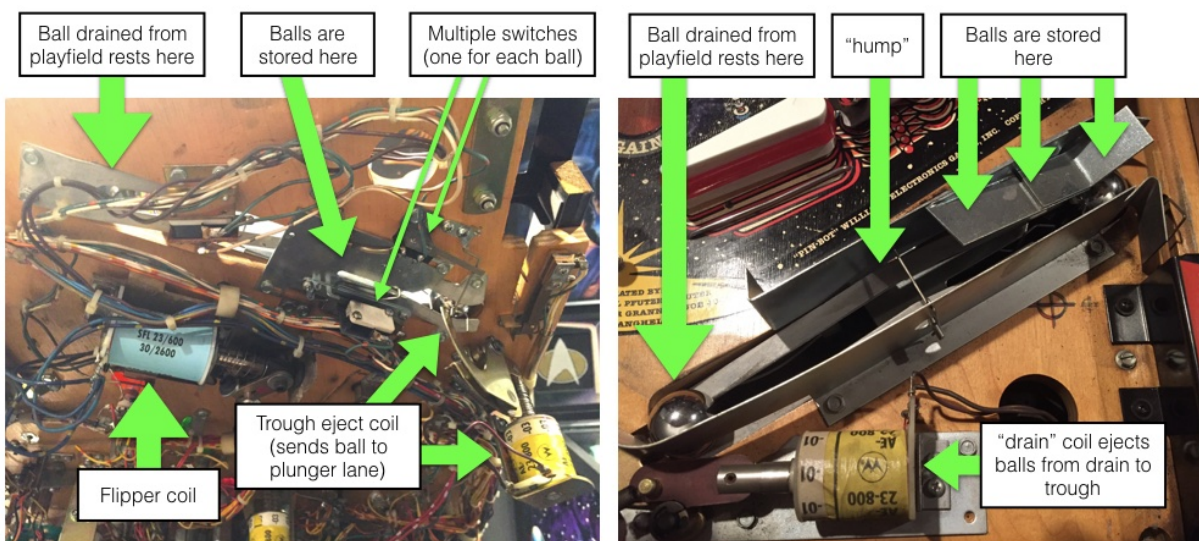
Also make sure that all your names are allowable names, meaning they are only letters, numbers, and the underscore, and that none of your names start with a number.

How to configure an older style trough with two coils and switches for each ball

This guide will show you how to configure MPF to use an older-style drain and trough combination that uses two coils (one to eject the ball from the drain hole and a second to release a ball into the plunger lane).

This guide is written for the types of systems where the trough side (after the “hump”) has multiple switches—one for each ball that’s sitting there.

Here’s an example of a Williams System 11 trough that uses this system, from a Pin*Bot machine:

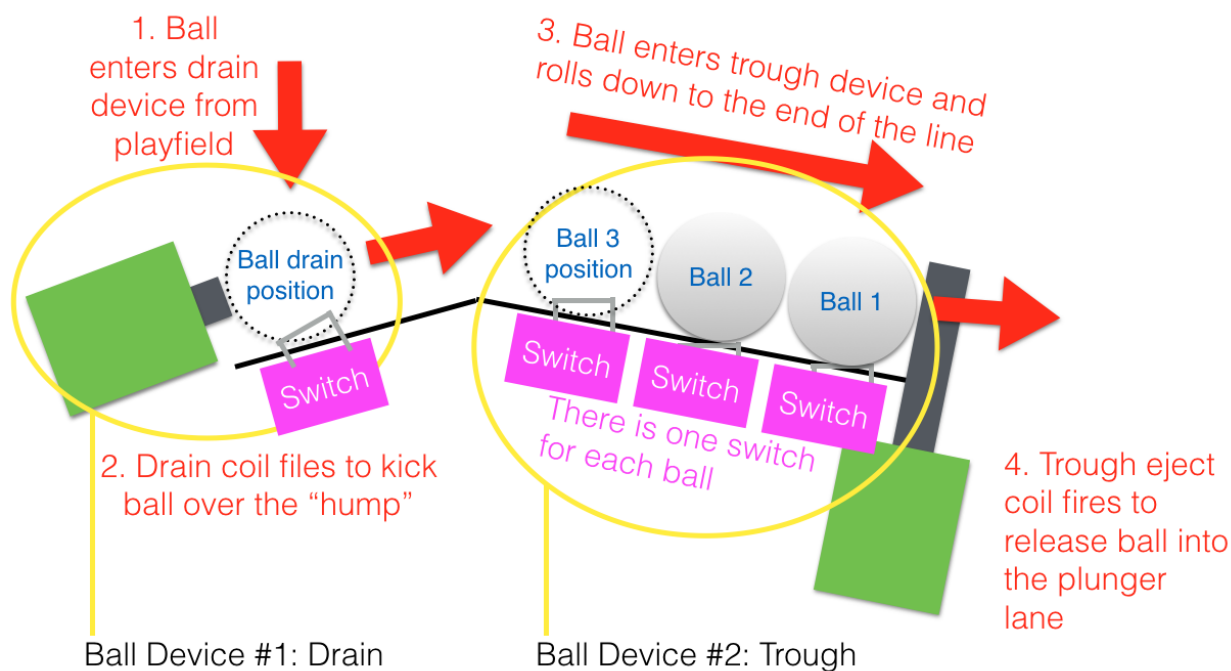


Bottom View
(under playfield)

Top View
(apron removed)

If your machine’s trough system is like this but you only have one switch on the trough side (like Gottlieb System 3 machines), then use [this guide](#) instead.

The following diagram shows how the layout that this guide is written for works: (This is a side view)



This style of trough and drain was used in Williams System 11 machines and early WPC machines

(Addams Family, T2, Hurricane, and a few others).

1. Add the switches

The first step is to add all the switches to the `switches:` section of your config file. Create an entry in your `switches:` section for the drain switch as well as each switch in your trough, like this: (This example has three switches in the trough. Yours may have more or less.)

```
switches:
  s_drain:
    number: 01
  s_trough1:
    number: 02
  s_trough2:
    number: 03
  s_trough3:
    number: 04
```

Note that we configured this switches with numbers 01 through 04, but you should use the actual switch numbers for your control system that the trough switches are connected to. (See [How to configure “number:” settings](#) for instructions for each type of control system.)

It makes no difference which switch is which (in terms of whether Switch 1 is on the left side or the right side). Also the actual switch names don’t really matter. We use `s_trough1` through `s_trough3` though you can call them `s_ball_trough_1` or `trough_ball_1` or `s_mr_potatohead`.

2. Add the coils

Next, create the entries in your `coils:` section for the drain eject coil and the trough release coil. Again, the names don’t matter. We’ll call them `c_drain_eject` and `c_trough_release` and enter them like this:

```
coils:
  c_drain_eject:
    number: 03
    pulse_ms: 20
  c_trough_release:
    number: 04
    pulse_ms: 20
```

Again, the `number:` entries in your config will vary depending on your actual hardware, and again, you can pick whatever name you want for your coil.

You’ll also note that we went ahead and entered `pulse_ms:` values of 20 which will override the default pulse times of 10ms. It’s hard to say at this point what values you’ll actually need. You can always adjust this at any time. You can play with the exact values in a bit once we finish getting everything set up.

Note that some trough coils use a shorter pulse to pop the ball into the plunger lane. However, some machines have gates or rotational devices that need to be active for much longer. So having a long pulse time, like `pulse_ms: 1000` (for one second) is totally fine. However, if the pulse time is over 255ms, then technically that coil is enabled and disabled versus pulsed, so in that case, you also need to add `allow_enable: true` which tells MPF it’s ok to enable this coil for more than 255ms.

In other words, a trough release time of 1s would look like this:

```
c_trough_release:
  number: 04
  pulse_ms: 1000
  allow_enable: true
```

3. Add your “drain” ball device

In MPF, anything that holds and releases a ball is a *ball device*. With this drain/trough setup, there are actually two ball devices—one for the drain and a second for the trough.

Let’s add the drain device first, which we’ll add to the `ball_devices:` section of your machine config. (If you don’t have that section add it now.)

Then in your `ball_devices:` section, create an entry called `bd_drain:`, like this:

```
ball_devices:
  bd_drain:
```

This means that you’re creating a ball device called *bd_drain*. We use the preface *bd_* to indicate that this is a ball device which makes it easier when we’re referencing them later. Then under your `bd_drain:` entry, you’ll start entering the configuration settings for your drain ball device.

- Add `ball_switches:` `s_drain` which means this device will use the `s_drain` switch to know whether or not this device has a ball.
- Add `eject_coil:` `c_drain_eject` which is the name of the coil that will eject the ball from the drain.
- Add `eject_targets:` `bd_trough` which tells MPF that this ball device ejects its balls into the device called *bd_trough*. (We’ll create that device in the next step.)
- Add `tags:` `drain` which tells MPF that balls entering this device mean that a ball has drained from the playfield.

Your drain device configuration should now look like this:

```
ball_devices:
  bd_drain:
    ball_switches: s_drain
    eject_coil: c_drain_eject
    eject_targets: bd_trough
    tags: drain
```

4. Add your “trough” ball device

Next create a second entry in the `ball_devices:` section called `bd_trough` that will be for the trough device that holds the balls that are ejected from the drain before they’re released into the plunger lane.

The configuration is pretty straightforward:

- Add `ball_switches`: `s_trough1`, `s_trough2`, `s_trough3` tells this device that those switches are used to count balls in the trough. (You may have more or less than 3. Also the order of these doesn't matter.
- Add `eject_coil`: `c_trough_release` which is the name of the coil that will be pulsed to eject the ball from the drain.
- Add `eject_targets`: `bd_plunger_lane` which tells MPF that this ball device ejects its balls into the device called *bd_plunger_lane*. (We won't actually create the plunger device in this How To guide, but you need to have it, so see the [Plungers & Ball Launch Devices](#) documentation for full details since there are lots of different types of plungers.
- Add `tags`: `home`, `trough` which tells MPF that it's ok to store unused balls here and that it's ok for balls to be here when games start.

Your trough device configuration should now look like this:

```
bd_trough:
  ball_switches: s_trough1, s_trough2, s_trough3
  eject_coil: c_trough_release
  eject_targets: bd_plunger_lane
  tags: home, trough
```

5. Configure your virtual hardware to start with balls in the trough

While we're talking about the trough, it's probably a good idea to configure MPF so that when you start it in virtual mode (with no physical hardware) that it starts with the trough full of balls. To do this, add a new section to your config file called `virtual_platform_start_active_switches:`. (Sorry this entry name is hilariously long.) As its name implies, *virtual_platform_start_active_switches:* lets you list the names of switches that you want to start in the "active" state when you're running MPF with the virtual platform interfaces.

The reason these only work with the virtual platforms is because if you're running MPF while connected to a physical pinball machine, it doesn't really make sense to tell MPF which switches are active since MPF can read the actual switches from the physical machine. So you can add this section to your config file, but MPF only reads this section when you're running with one of the virtual hardware interfaces. To use it, simply add the section along with a list of the switches you want to start active. For example:

```
virtual_platform_start_active_switches:
  s_trough1
  s_trough2
  s_trough3
```

Here's the complete config

```
#config_version=4

switches:
  s_drain:
    number: 01
  s_trough1:
    number: 02
```



```

s_trough2:
  number: 03
s_trough3:
  number: 04

coils:
  c_drain_eject:
    number: 03
    pulse_ms: 20
  c_trough_release:
    number: 04
    pulse_ms: 20

ball_devices:
  bd_drain:
    ball_switches: s_drain
    eject_coil: c_drain_eject
    eject_targets: bd_trough
    tags: drain
  bd_trough:
    ball_switches: s_trough1, s_trough2, s_trough3
    eject_coil: c_trough_release
    eject_targets: bd_plunger_lane
    tags: home, trough

  # bd_plunger is a placeholder just so the trough's eject_targets are valid
  bd_plunger_lane:
    tags: ball_add_live
    mechanical_eject: true

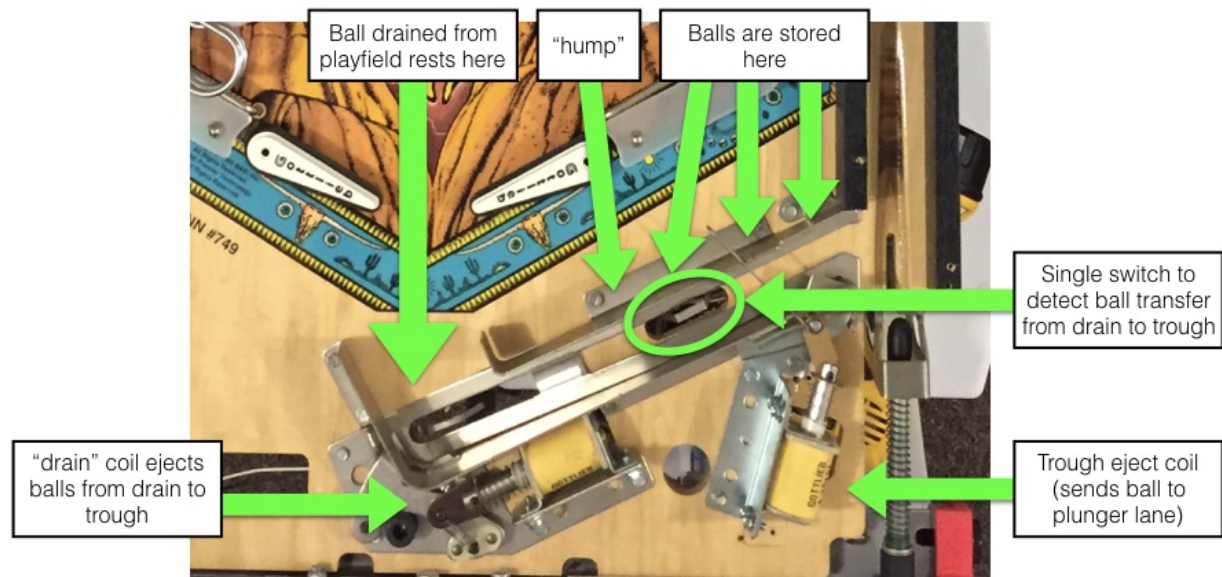
virtual_platform_start_active_switches:
  s_trough1
  s_trough2
  s_trough3

```

How to configure an older style trough with two coils and only one ball switch

This guide will show you how to configure MPF to use an older-style drain and trough combination that uses two coils (one to eject the ball from the drain hole and a second to release a ball into the plunger lane).

This guide is written for the types of devices that have only have one switch on the trough side, like this example of a Gottlieb System 3 machine (Brooks 'n Dunn):

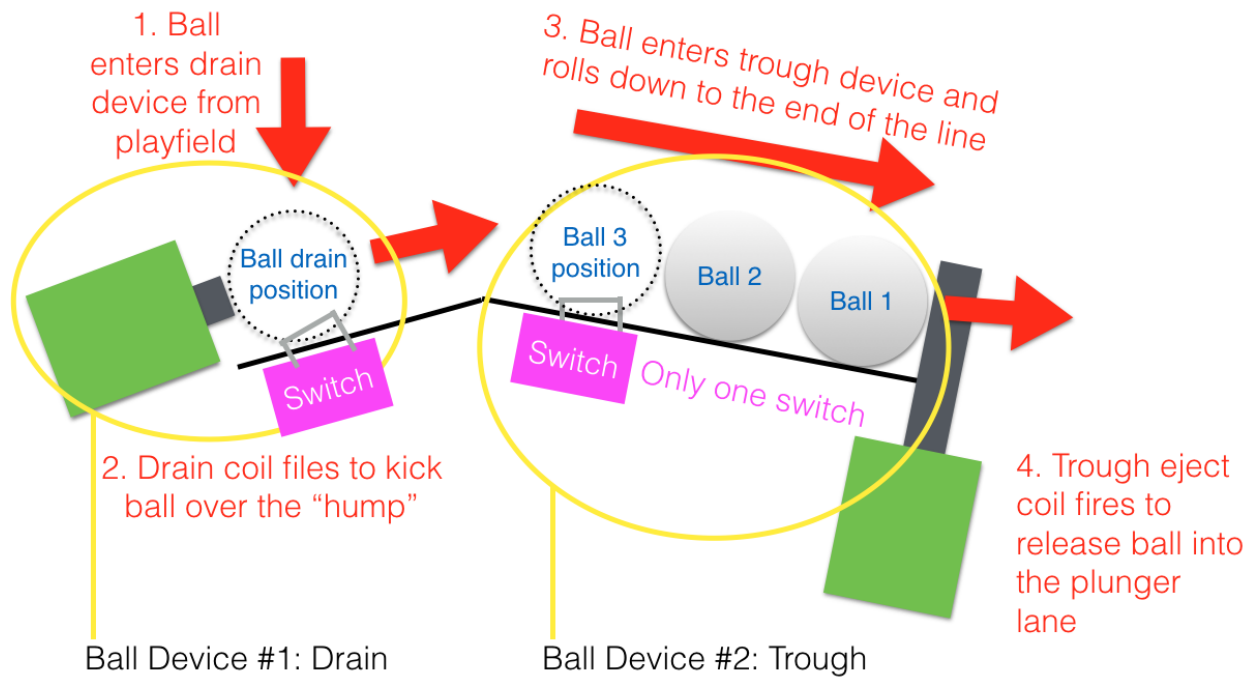


Top View
(apron removed)

If your trough system has multiple switches in the trough (one for each ball), then use [this guide](#) instead.

In the types of troughs this guide is for, a ball ejected from the drain over the hump into the trough will only momentarily activate the trough switch as the ball rolls by, unless the trough is full, in which case the last ball that goes into it sits on the switch.

The following diagram shows a more clear view of the type of trough system this guide is for: (This is a side view)



1. Add the switches

The first step is to add all the switches to the switches: section of your config file. Create an entry in your switches: section for the drain switch as well as each switch in your trough, like this: (This example has three switches in the trough. Yours may have more or less.)

```
switches:
  s_drain:
    number: 01
  s_trough_enter:
    number: 02
```

Note that we configured this switches with numbers 01 and 02, but you should use the actual switch numbers for your control system that the switches are connected to. (See [How to configure “number:” settings](#) for instructions for each type of control system.)

It makes no difference what the actual switch names are. We use `s_drain` and `s_trough_entry`, though you can call them whatever you want.

2. Add the coils

Next, create the entries in your coils: section for the drain eject coil and the trough release coil. Again, the names don't matter. We'll call them `c_drain_eject` and `c_trough_release` and enter them like this:

```
coils:
  c_drain_eject:
    number: 03
    pulse_ms: 20
```



```
c_trough_release:
  number: 04
  pulse_ms: 20
```

Again, the `number:` entries in your config will vary depending on your actual hardware, and again, you can pick whatever name you want for your coil.

You'll also note that we went ahead and entered `pulse_ms:` values of 20 which will override the default pulse times of 10ms. It's hard to say at this point what values you'll actually need. You can always adjust this at any time. You can play with the exact values in a bit once we finish getting everything set up.

Note that some trough coils use a shorter pulse to pop the ball into the plunger lane. However, some machines have gates or rotational devices that need to be active for much longer. So having a long pulse time, like `pulse_ms: 1000` (for one second) is totally fine. However, if the pulse time is over 255ms, then technically that coil is enabled and disabled versus pulsed, so in that case, you also need to add `allow_enable: true` which tells MPF it's ok to enable this coil for more than 255ms.

In other words, a trough release time of 1s would look like this:

```
c_trough_release:
  number: 04
  pulse_ms: 1000
  allow_enable: true
```

3. Add your “drain” ball device

In MPF, anything that holds and releases a ball is a *ball device*. With this drain/trough setup, there are actually two ball devices—one for the drain and a second for the trough.

Let's add the drain device first, which we'll add to the `ball_devices:` section of your machine config. (If you don't have that section add it now.)

Then in your `ball_devices:` section, create an entry called `bd_drain:`, like this:

```
ball_devices:
  bd_drain:
```

This means that you're creating a ball device called *bd_drain*. We use the preface *bd_* to indicate that this is a ball device which makes it easier when we're referencing them later. Then under your `bd_drain:` entry, you'll start entering the configuration settings for your drain ball device.

- Add `ball_switches: s_drain` which means this device will use the *s_drain* switch to know whether or not this device has a ball.
- Add `eject_coil: c_drain_eject` which is the name of the coil that will eject the ball from the drain.
- Add `eject_targets: bd_trough` which tells MPF that this ball device ejects its balls into the device called *bd_trough*. (We'll create that device in the next step.)
- Add `tags: drain` which tells MPF that balls entering this device mean that a ball has drained from the playfield.

Your drain device configuration should now look like this:


```
ball_devices:
  bd_drain:
    ball_switches: s_drain
    eject_coil: c_drain_eject
    eject_targets: bd_trough
    tags: drain
```

4. Add your “trough” ball device

Next create a second entry in the `ball_devices:` section called `bd_trough` that will be for the trough device that holds the balls that are ejected from the drain before they’re released into the plunger lane.

The configuration is pretty straightforward:

- Add `entrance_switch: s_trough_enter` which tells MPF which switch is used as the “entrance” switch to this device. (An entrance switch is the switch that’s momentarily activated as balls enter this device.)
- Add `entrance_switch_full_timeout: 500ms` which tells MPF that if the entrance switch stays active for more than this amount of time, that means that this device is full.
- Add `ball_capacity: 3` (or whatever the number of balls is that can be stored on the trough side). This tells MPF how many balls are in this device when a ball is sitting on the entrance switch.
- Add `eject_coil: c_trough_release` which is the name of the coil that will be pulsed to eject the ball from the drain.
- Add `eject_targets: bd_plunger_lane` which tells MPF that this ball device ejects its balls into the device called *bd_plunger_lane*. (We won’t actually create the plunger device in this How To guide, but you need to have it, so see the [Plungers & Ball Launch Devices](#) documentation for full details since there are lots of different types of plungers.
- Add `tags: home, trough` which tells MPF that it’s ok to store unused balls here and that it’s ok for balls to be here when games start.

Your trough device configuration should now look like this:

```
bd_trough:
  entrance_switch: s_trough_enter
  entrance_switch_full_timeout: 500ms
  ball_capacity: 3
  eject_coil: c_trough_release
  eject_targets: bd_plunger_lane
  tags: trough, home
```

5. Configure the balls installed

One of the downsides of only having one switch in the trough is that if that switch is not active, then MPF doesn’t actually know how many balls are in it. (In the example diagram at the beginning of this guide where the trough can hold three balls, if that trough entry switch is not active, then there could be zero, 1, or 2 balls in the trough.)

MPF is able to keep track of how many balls are in the trough by tracking balls entered versus balls released. However when MPF starts up, if that entrance switch isn't active, then it won't know how many balls are there.

There's a setting in the machine config called `machine:balls_installed:` that tells MPF how many actual balls are installed in the machine. So when MPF starts, it can count up all the balls in all the devices and see if they're all there or if any are missing. Since that's a bit tricky with the single switch in the trough, you telling MPF how many total balls are installed in the machine help it know what to do if that entrance switch isn't active when MPF starts up.

Here's an example from the machine config:

```
machine:
  balls_installed: 4
```

6. Configure your virtual hardware to start with balls in the trough

While we're talking about the trough, it's probably a good idea to configure MPF so that when you start it in virtual mode (with no physical hardware) that it starts with the trough full of balls. To do this, add a new section to your config file called `virtual_platform_start_active_switches:`. (Sorry this entry name is hilariously long.) As its name implies, *virtual_platform_start_active_switches:* lets you list the names of switches that you want to start in the "active" state when you're running MPF with the virtual platform interfaces.

The reason these only work with the virtual platforms is because if you're running MPF while connected to a physical pinball machine, it doesn't really make sense to tell MPF which switches are active since MPF can read the actual switches from the physical machine. So you can add this section to your config file, but MPF only reads this section when you're running with one of the virtual hardware interfaces. To use it, simply add the section along with a list of the switches you want to start active. For example:

```
virtual_platform_start_active_switches:
  s_trough_enter
```

Here's the complete config

```
#config_version=4

switches:
  s_drain:
    number: 01
  s_trough_enter:
    number: 02

coils:
  c_drain_eject:
    number: 03
    pulse_ms: 20
  c_trough_release:
    number: 04
    pulse_ms: 20
```



```

ball_devices:
  bd_drain:
    ball_switches: s_drain
    eject_coil: c_drain_eject
    eject_targets: bd_trough
    tags: drain
  bd_trough:
    entrance_switch: s_trough_enter
    entrance_switch_full_timeout: 500ms
    ball_capacity: 3
    eject_coil: c_trough_release
    eject_targets: bd_plunger_lane
    tags: trough, home

# bd_plunger is a placeholder just so the trough's eject_targets are valid
bd_plunger_lane:
  tags: ball_add_live
  mechanical_eject: true

machine:
  balls_installed: 4

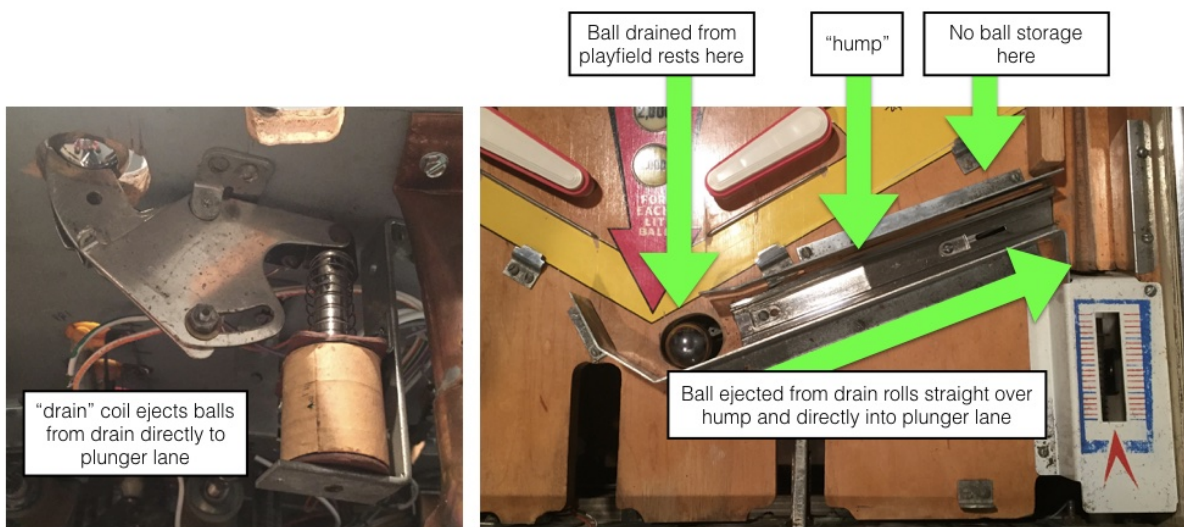
virtual_platform_start_active_switches:
  s_trough_enter

```

How to configure a classic single-ball trough

This guide will show you how to configure MPF to use an older-style single ball drain. This is the type of configuration that most (all?) single-ball machines use, from EM machines of the 1950s through electronic single ball machines of the early 1980s.

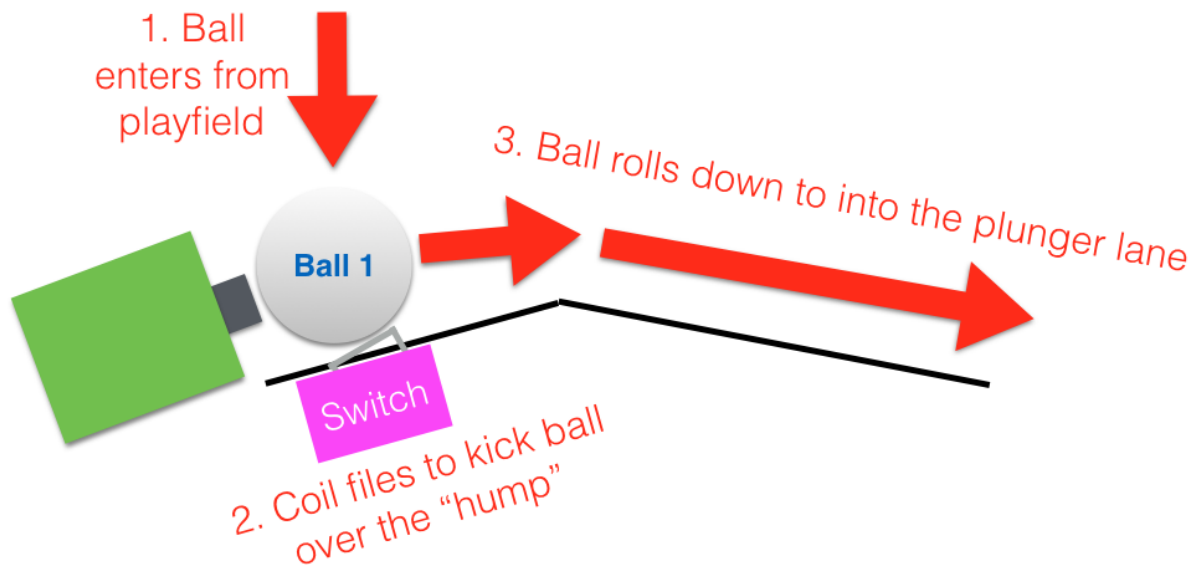
Here's an example from a Gottlieb Big Shot (1974 EM):



Bottom View
(under playfield)

Top View
(apron removed)

And here's a diagram which shows this a bit more clearly: (This is a side view)



1. Add the drain switch

The first step is to add the drain switch to the switches: section of your machine config file.

```
switches:
  s_drain:
    number: 01
```

Note that we configured this switches with number 01, but you should use the actual switch number for your control system that the switch is connected to. (See [How to configure "number:" settings](#) for instructions for each type of control system.)

2. Add the eject coil

Next, create the entry in your coils: section for the drain eject coil. Again, the name doesn't matter. We'll call it `c_drain_eject` and enter it like this:

```
coils:
  c_drain_eject:
    number: 03
    pulse_ms: 20
```

Again, the number: entry in your config will vary depending on your actual hardware, and again, you can pick whatever name you want for your coil.

You'll also note that we went ahead and entered a pulse_ms: value of 20 which will override the default pulse times of 10ms. It's hard to say at this point what values you'll actually need. You can always adjust this at any time. You can play with the exact values in a bit once we finish getting everything set up.

3. Add your “drain” ball device

In MPF, anything that holds and releases a ball is a *ball device*. So in your `ball_devices:` section, create an entry called `bd_drain:` like this: (If you don’t have that section add it now.)

```
ball_devices:
    bd_drain:
```

This means that you’re creating a ball device called *bd_drain*. We use the preface *bd_* to indicate that this is a ball device which makes it easier when we’re referencing them later. Then under your `bd_drain:` entry, you’ll start entering the configuration settings for your drain ball device.

- Add `ball_switches:` `s_drain` which means this device will use the *s_drain* switch to know whether or not this device has a ball.
- Add `eject_coil:` `c_drain_eject` which is the name of the coil that will eject the ball from the drain.
- Add `eject_targets:` `bd_plunger_lane` which tells MPF that this ball device ejects its balls into the device called *bd_plunger_lane*. (We won’t actually create the plunger device in this How To guide, but you need to have it, so see the *Plungers & Ball Launch Devices* documentation for full details since there are lots of different types of plungers.
- Add `tags:` `drain`, `home`, `trough` which tells MPF that balls entering this device mean that a ball has drained from the playfield, that it’s ok to start a game with a ball here, and that this device is used to store unused balls.

Your drain device configuration should now look like this:

```
ball_devices:
    bd_drain:
        ball_switches: s_drain
        eject_coil: c_drain_eject
        eject_targets: bd_plunger_lane
        tags: drain, home, trough
```

4. Configure your virtual hardware to start with balls in the trough

While we’re talking about the trough, it’s probably a good idea to configure MPF so that when you start it in virtual mode (with no physical hardware) that it starts with the trough full of balls. To do this, add a new section to your config file called `virtual_platform_start_active_switches:`. (Sorry this entry name is hilariously long.) As its name implies, *virtual_platform_start_active_switches:* lets you list the names of switches that you want to start in the “active” state when you’re running MPF with the virtual platform interfaces.

The reason these only work with the virtual platforms is because if you’re running MPF while connected to a physical pinball machine, it doesn’t really make sense to tell MPF which switches are active since MPF can read the actual switches from the physical machine. So you can add this section to your config file, but MPF only reads this section when you’re running with one of the virtual hardware interfaces. To use it, simply add the section along with a list of the switches you want to start active. For example:

```
virtual_platform_start_active_switches:
    s_drain
```


Here's the complete config

```
#config_version=4

switches:
  s_drain:
    number: 01

coils:
  c_drain_eject:
    number: 03
    pulse_ms: 20

ball_devices:
  bd_drain:
    ball_switches: s_drain
    eject_coil: c_drain_eject
    eject_targets: bd_plunger_lane
    tags: drain, home, trough

    # bd_plunger is a placeholder just so the trough's eject_targets are valid
  bd_plunger_lane:
    tags: ball_add_live
    mechanical_eject: true

virtual_platform_start_active_switches:
  s_drain
```


CHAPTER 8

Game Logic

Most (or potentially all?) of your game logic can be configured in the MPF config files. Each section here contains the description, how to guides, links to tutorials, event listings, and configuration

Note: Most of the “How To” guides for these sections still need to be written.

Achievements

Related Config File Sections

<i>achievements:</i>

Changed in version 0.32.

- [*Monitorable Properties*](#)
- [*Related How To guides*](#)
- [*Related Events*](#)

MPF uses “achievements” to track major goals that a player must achieve throughout the progression of a game. Achievements typically have an associated light or LED on the playfield (though not always), and they’re tracked separately per player.

The biggest use for achievements is for modes, where you have a bunch of modes in a machine which each have a light, and as you complete the modes, the light turns on. (In many cases the lights/LEDs associated with achievements have multiple states, for example, they’re “off” when not complete, “flashing” when active, “on” when complete, etc.)

Here are some examples from real machines that would map to “achievements” in MPF:

- **Attack from Mars:**
 - The countries (France, Germany, Italy, England, USA)
 - The Capture inserts (Capture 1, Capture 2, Capture 3)
 - The Big -O- Beam inserts (1, 2, and 3)
 - The Atomic Blaster inserts (1, 2, and 3)
 - The Blue circles to Rule The Universe (Super Jackpot, Super Jets, Martian Attack Multiball, Total Annihilation, Conquer Mars, and 5-way Combo)
- **Indiana Jones: The Pinball Adventure:**
 - The Modes inserts (Streets of Cairo, Well of Souls, Monkey Brains, etc.)
- **The Addams Family:**
 - Mansion Modes (Raise the Dead, Hit Cousin It, Mamushka, etc.)
- **Star Trek: The Next Generation:**
 - Missions (Time Rift, Asteroid Threat, Rescue, Q’s Challenge, etc.)
- **Red & Ted’s Road Show:**
 - The cities on the Map (each city is an achievement)
 - The wheel (Lunch Time, Flying Rocks, Big Blast, Special, etc.)

You can have as many achievements as you want in your machine, and you can re-use the same lights/LEDs for different achievements in different modes. (For example, you might have red arrow inserts that turn on and off to highlight shots in your base mode, but then you might have a timed mode where those inserts are mapped to achievements and they’re all lit, and they go out as they’re hit.)

You can also group individual achievements into “achievement groups”. This is useful for tracking when all the achievements in the group have been complete (e.g. to light a wizard mode). You can also use achievement groups to “rotate” lit achievements (e.g. every slingshot hit changes the achievement that’s flashing, but it only rotates through incomplete achievements.)

Monitored Properties

For *dynamic values* and *conditional events*, the prefix for achievements is `device.achievements.<name>`.

state The string name of this state this achievement is in. Options will be one of the following: *disabled*, *enabled*, *started*, *stopped*, *selected*, or *completed*. If this achievement is in a mode that has not been started yet, then its state will be an empty string.

Related How To guides

- [Recipe: The Addams Family Mansion Awards](#)

Related Events

- *achievement_(name)_state_(state)*
- Plus any custom events as defined in the achievement’s configuration in your config files.

Achievement Groups

Related Config File Sections

<i>achievement_groups:</i>

New in version 0.32.

- *Monitorable Properties*
- *Related How To guides*
- *Related Events*

Achievement groups are used to group together individual achievements.

If you look at the real-world examples we used in the achievements documentation, each of the entries in that list is an achievement “group” that’s made up of individual achievements.

For example, in *The Addams Family*, the mansion awards would be individual achievements, for example:

- 9 Mil
- 6 Mil
- 3 Mil
- Thing
- Quick Multiball
- Grave Yard at Max
- Raise the Dead
- Etc.

Each of those individual achievements has a state (enabled, started, completed, etc.)

If you were building a config for *The Addams Family (TAF)* with MPF, you would create an achievement group called “Mansion Awards”, and then you would add the individual achievements to that group.

The achievement group will let you perform group-level actions on the achievements in the group. For example:

- Randomly select one of the incomplete achievements (so you can flash that achievement’s light to indicate it’s selected).
- Change which achievement is selected. (In *TAF*, each hit to a pop bumper changes the lit achievement, so you’d configure your achievement group to pick a new achievement when the pop bumper hit event was posted.)

- Post an event when all achievements are complete (to start a wizard mode, etc.)
- Post a “start” event for whichever achievement is lit (In *TAF*, you shoot the lit electric chair or the swamp to start the flashing achievement.)

Monitorable Properties

For *dynamic values* and *conditional events*, the prefix for achievement groups is `device.achievement_groups.<name>`.

enabled Boolean (true/false) as to whether this achievement group is enabled.

selected_member The achievement in the group that is currently in the selected state, or *None* if no achievement is selected.

Related How To guides

- *Recipe: The Addams Family Mansion Awards*

Related Events

- Custom events as defined in the achievement’s configuration in your config files.

Ball Holds

Related Config File Sections
<i>ball_holds:</i>

- *Monitorable Properties*
- *Related How To guides*
- *Related Events*

MPF’s *ball holds* are used to temporarily hold a ball that has entered a *Ball Devices* while something else happens.

The most common use cases are to hold a ball while you play a show, or while a video mode is going on. Ball holds do not affect the balls in play count, and if all other balls drain while a ball hold is in progress, the players ball does not end.

Ball holds are *not* used to lock balls for multiball. (See the `ball_locks:` device for that.

You can have lots of different ball holds in your game, typically configured per mode.

Monitorable Properties

For *dynamic values* and *conditional events*, the prefix for ball holds is `device.ball_holds.<name>`.

balls_held The number of balls this ball hold is currently holding

enabled Boolean (true/false) which shows whether this ball hold is enabled.

Related How To guides

Todo: TODO

Related Events

- [*ball_hold_\(name\)_balls_released*](#)
- [*ball_hold_\(name\)_full*](#)
- [*ball_hold_\(name\)_held_ball*](#)

Ball Locks

Related Config File Sections

<i>ball_locks:</i>

- [*Monitorable Properties*](#)
 - [*Related How To guides*](#)
 - [*Related Events*](#)

MPF's *ball locks* are used to hold a ball that has entered a [*Ball Devices*](#) towards multiball.

Warning: Ball locks will be removed from MPF after v0.33. They have been replaced with [*Multiball Locks*](#), so if you're setting this up for the first time, you should use them instead.

Note: If you just want to temporarily hold a ball while something else is happening (like during a video mode or while some award show is playing), use MPF's `ball_holds:` section, not a ball lock.

Ball locks are “logical” (not physical), so different ball locks can exist in different modes that hold balls in the same device (depending on what mode is running).

Ball lock devices track the number of balls “locked” on a per-player basis, so even if one player empties out a physical ball device, the ball lock for another player will know how many balls that player had locked, even if the number of balls in a contained physical ball device doesn't match.

You can have lots of different ball locks in your game, typically configured per mode.

Monitorable Properties

For *dynamic values* and *conditional events*, the prefix for ball locks is `device.ball_locks.<name>`.

balls_locked The number of balls locked

enabled Boolean (true/false) which shows whether this ball lock is enabled.

lock_queue List of pairs of the device & ball counts that are queued to be released.

Related How To guides

Todo: TODO

Related Events

- *ball_lock_(name)_balls_released*
- *ball_lock_(name)_full*
- *ball_lock_(name)_locked_ball*

Ball Saves

Related Config File Sections
<i>ball_saves:</i>

- *Monitorable Properties*
 - *Related How To guides*
 - *Related Events*

MPF uses *ball saves* to automatically re-serve a ball that has drained. (Essentially this means the ball drain doesn't count.)

Ball saves are typically used in several scenarios:

- Give the player their ball back if they drain right after their ball starts.
- Give the player their ball back if there's a particularly wicked shot that tends to drain which the game designers feel bad about. (You should avoid this if possible, and instead, as Lyman Sheets would say, "Fix your f-ing game layout!")
- Use to make a timed mode where the player has unlimited drains.
- Etc.

You can configure ball saves to have various start and stop events and timers, and you can configure multiple ones in different modes that do different things.

Monitorable Properties

For *dynamic values* and *conditional events*, the prefix for ball saves is `device.ball_saves.<name>`.

enabled Boolean (true/false) which shows whether this ball hold is enabled.

saves_remaining How many balls saves are remaining.

state String value of the state of this ball save. Values will be one of the following: *enabled*, *disabled*, *hurry_up*, or *grace_period*.

timer_started Boolean (true/false) which shows whether the timer is started.

Related How To guides

Todo: TODO

Related Events

- *ball_save_(name)_disabled*
- *ball_save_(name)_enabled*
- *ball_save_(name)_grace_period*
- *ball_save_(name)_hurry_up*
- *ball_save_(name)_saving_ball*
- *ball_save_(name)_timer_start*

Ball Search

Related Config File Sections
<i>ball_devices:</i>
<i>switches:</i>
<i>playfields:</i>
<i>example ball_search</i>

- *Related How To guides*
 - *Related Events*

Note: Ball search is off by default in MPF because it might hurt users not expecting it. In a prototype game it might trigger quite frequently and coils can seriously injure humans. To turn it on follow [How to configure Ball Search](#).

MPF contains ball search functionality which is used to try to dislodge a stuck ball if MPF thinks there's a ball loose on the playfield but it hasn't hit any playfield switches in awhile and the player is not holding the flipper button in.

Ball searching in MPF has multiple "rounds", with the early rounds doing a simple search that doesn't screw anything up (like firing pop bumpers and pulsing eject coils from ball devices that don't contain any balls), but after a few rounds of that, if it still hasn't found the ball, it can start to do things like resetting drop targets.

Eventually MPF will give up and mark the ball as lost and kick a new ball into play.

Everything is fully configurable, including the timeouts, the order devices are searched, the number of rounds, etc.

Ball search in MPF is fairly automatic. It's enabled when MPF thinks that balls are on the playfield, and disabled when no balls are free. (This means that even when a machine tilts, ball search is still active until the balls drain, etc.)

Related How To guides

- [How to configure Ball Search](#)

Related Events

- [ball_search_failed](#)
- [ball_search_started](#)
- [ball_search_stopped](#)
- [flipper_cradle](#)
- [flipper_cradle_release](#)

How to configure Ball Search

To enable ball search set `enable_ball_search` to True for your playfield(s). In most cases, this is as simple as this:

```
playfields:
  playfield:
    enable_ball_search: True
```

Ball search will run in multiple phases with increasing intensity (phase 1 to 3) and give up afterwards. To change the timeout before ball search starts when no ball was seen by MPF, change `ball-search-timeout`. Similarly, `ball-search-interval` determines the delay between coil fires during search. You can further configure ball search per [playfield](#).

Coils are included indirectly using their devices. Most devices allow you to configure their order in ball search using the `ball_search_order` attribute (see the [example ball_search](#)). By default flippers are not included in ball search. However, you might want to enable it for upper playfield flippers:

```
flippers:
  f_upper_flipper_left:
    ball_search_order: 15
```



```
include_in_ball_search: True
[...]
```

Make sure to include the tag *playfield_active* in all playfield switches which are not bound to devices. For instance do not put that tag into your plunger switch but put it to target, inlane and outlane switches.

If you want to pulse a standalone coil which is not bound to any device, you can use *pulse_events* on *ball_search_phase_x_searches* (replace x with phase 1 to 3).

Ball Tracking

Keeping track of where all the balls are at any given time is a big part of a pinball. There are four components that make up MPF's ball tracking and management system:

- The Ball Controller, which is a core MPF module that manages everything.
- Individual *Ball Devices* (troughs, locks, etc.) which track how many balls they're currently holding, request new balls, eject balls, etc.
- The *Playfields* device which is a special type of ball device that tracks how many balls are loose on the playfield at any given time.
- Individual *Diverters* which are integral in routing balls to devices that request them.

These four components are active at all times—regardless of whether or not a game is in progress. In other words, if MPF is running, it's tracking balls.

Note that tracking the number of balls on a playfield is somewhat complex. See the *How MPF tracks the number of balls on a playfield* guide for important details about how this works in MPF.

End of Ball Bonus

MPF contains a built-in end of ball bonus mode which you can use to calculate and display a player's bonus score when they drain a ball.

The built-in bonus mode can handle bonus scoring, multipliers, awarding points based on any player variables, and other “standard” things. You can also extend and enhance it if you have specific requirements that aren't covered by the built-in mode.

Related How To guides

- *How to configure End of Ball Bonus*

Related Events

- *bonus_multiplier*
- *bonus_start*
- *bonus_subtotal*

- Plus other events defined in your bonus mode's `bonus_entries` settings

How to configure End of Ball Bonus

This guide walks you through configuring an end-of-ball Bonus mode in MPF.

1. Add the bonus mode to your machine's list of modes

MPF contains a built-in bonus mode that you can use which should contain everything you need. To use it, first simply add `- bonus` to your machine config's `modes:` section, like this:

```
#config_version=4

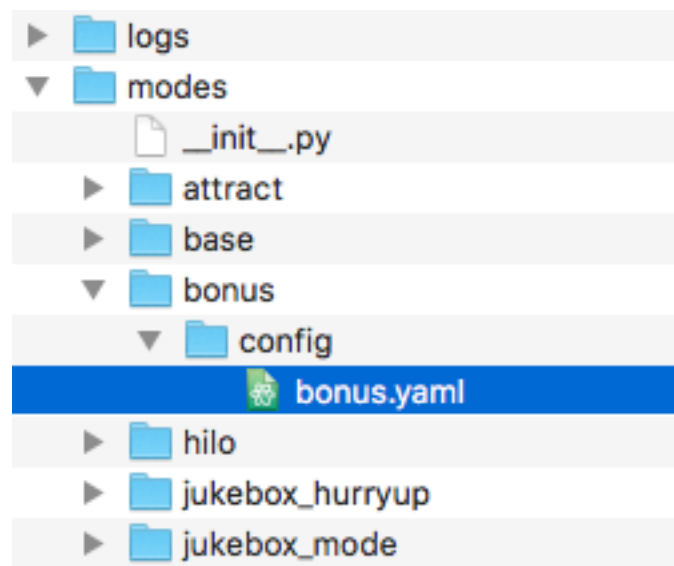
modes:
  - base
  - some_other_modes
  - jackpot
  - credits
  - tilt
  - bonus # just add bonus to this list, don't forget the dash
```

The bonus mode is automatically configured to start when the ball ends (as long as the machine is not tilted), running at priority 500.

2. Create your bonus mode folders

Even though the bonus mode is built-in, you'll still need to add a bonus folder to your machine's *modes* folder. Then in there, add a config folder, and finally, create a file in the config folder called `bonus.yaml`. (So this is just like any other mode so far.)

It should look something like this:



3. Add the bonus mode to your machine-wide modes list

Remember that when you create a new mode, you need to add it to the `modes:` section of your machine-wide config. (Why doesn't MPF just automatically detect modes based on what folders it finds? Because you might want to have different sets of configs that use different modes, or you might want to disable a mode you're testing, etc.)

So just add `- bonus` to the list of modes in the `modes:` section of your machine-wide config, like this:

```
# this is your machine-wide config.yaml

modes:
  - base
  - jukebox_mode
  - skill_shot
  - jukebox_hurryup
  - managers_choice_base
  - managers_choice_multiball
  - managers_choice_timed_mode
  - managers_choice_lit
  - mystery_lit
  - wizard_advance_lit
  - mission_rotator
  - light_mission_select
  - play_poker
  - money_bags
  - world_tour
  - music_awards
  - jukebox_two_ball
  - bonus                # just add bonus to the list of existing modes
```

4. Think about what you want to score bonus on

Most modern pinball machines have bonus scores based on multiple things.

TODO finish this. . .

4. Add some settings to your bonus mode config

Now go back into your bonus mode folder open up `bonus.yaml` config file (which should be empty at this point), and enter a basic config:

```
#config_version=4

mode_settings:
  bonus_entries:
```

TODO

Carousel

Related Config File Sections
<i>carousel (example config files)</i>

Changed in version 0.33.

A carousel allows you to create process for the player to select from a list of items such as selecting a mode to play. The carousel is implemented as a mode. The player can move through a list of items that you provide on the display or cycle through playfield inserts.

A common use of the carousel is to create a mode selection process. For example, the player can scroll through a list of modes on the display. Each mode could be presented to the user as a slide. The player can move from slide to slide using the flippers. Once the player decides which mode to play, he can select the mode by hitting the start button or both flippers at once. This is just one example of how you could implement a carousel as a mode selection process.

There is a reference to a code file in here so be careful to include that reference. You don't need to download any code as it is already in your MPF installation. Here is the process of configuring a carousel:

- Create a mode folder and config file <machine>/modes/carousel/config/carousel.yaml
- Add the code to mode: section:

```
code: mpf.modes.carousel.code.carousel.Carousel
```

- Create your selectable items. These could be your mode names but you can name them anything for now.

```
selectable_items: terra, pyro, space, liquid
```

- Select the event(s) that choose the item. For example, the start button. You could think of this as the "enter key"

```
select_item_events: s_start_active
```

- Select the event that moves to the next item in the list of items

```
next_item_events: s_right_flipper_active
```

- Select the event that moves back to the previous item in the list of items

```
previous_item_events: s_left_flipper_active
```

There are two events of importance here:

- carousel_<item>_highlighted
- carousel_<item>_selected

You can use the carousel_<item>_highlighted event to display a slide showing the name of the mode to the player.

You can then use the carousel_<item>_selected event to start the mode that was selected by the player.


```
#config_version=4
mode:
  start_events: ball_starting
  stop_events: carousel_terra_selected # not sure what event to use here???
  code: mpf.modes.carousel.code.carousel.Carousel

mode_settings:
  selectable_items: terra, pyro, space, liquid
  select_item_events: s_start_active
  next_item_events: s_right_flipper_active
  previous_item_events: s_left_flipper_active

slide_player:
  carousel_terra_highlighted: select_terra
  carousel_liquid_highlighted: select_liquid
  carousel_space_highlighted: select_space
  carousel_pyro_highlighted: select_pyro

slides:
  select_liquid:
    widgets:
      - type: text
        text: LIQUID METAL
        font_size: 100
        color: yellow
    transition:
      type: move_in
      direction: right
  select_terra:
    widgets:
      - type: text
        text: TERAFORM
        font_size: 100
        color: yellow
    transition:
      type: move_in
      direction: right
  select_space:
    widgets:
      - type: text
        text: SPACE OUT
        font_size: 100
        color: yellow
    transition:
      type: move_in
      direction: right
  select_pyro:
    widgets:
      - type: text
        text: PYRO
        font_size: 100
        color: yellow
    transition:
      type: move_in
      direction: right
```


Coins & Credits

Related Config File Sections

<i>credits:</i>

MPF contains support for “coins & credits” which basically means you can configure your machine to require money to play.

The credits system has several features and options, including:

- Configuration of different coin/price values per coin switch.
- Tracking money and/or tokens.
- Set price tiers (1 credit for 50 cents, 5 credits for 2 dollars, etc.)
- Specify max credits and credit expiration times
- Retain credits even when the machine is powered off
- Get access to a “credits string” machine variable that will show the number of credits (or configurable free play text) for use on your display.
- Flexible events you can use to show display items based on credits being added, insert coin messages, max credits reached, etc.

Related How To Guides

TODO

Related Events

<i>credits_added</i>

<i>enabling_credit_play</i>

<i>enabling_free_play</i>

<i>max_credits_reached</i>
--

<i>not_enough_credits</i>

Combo Switches (“flipper cancel”, etc.)

Related Config File Sections

<i>combo_switches:</i>
--

New in version 0.32.

- | |
|--|
| <ul style="list-style-type: none"> • <i>Monitorable Properties</i> • <i>Related How To guides</i> • <i>Related Events</i> |
|--|

MPF contains support for “combo switches” which are special combinations of switches that post events when they’re hit together.

The most basic example of this is the “flipper cancel” combination, where a player can cancel a show or bonus by hitting both flippers at the same time. In fact MPF contains built-in support for the flipper cancel combo. If you add the tag `left_flipper` to your left flipper switch, and `right_flipper` to your right flipper switch, then whenever the player hits both flippers at the same time, an MPF event called *flipper_cancel* will be posted.

Combo switches are also used for things like different kinds of skill shots. For example, in *Attack From Mars*, if the player hits the launch button, the ball is launched into the pop bumper area, but if the player holds down the left flipper button while pressing the launch button, a pin in the upper playfield is lowered and the ball is delivered to the flippers for an attempt at a super skill shot. The left flipper + launch button combination is something you can enable with MPF’s combo switches.

MPF’s combo switches also generate events once both switches are hit together, then one switch is tapped while the other is held in. This can be used to scroll through certain information screens with one button while the combo is active.

You can set various timing options for combo switches, including how close together the two switches have to be hit to count as a combo, how long they have to be held, and how long they have to be released.

Monitorable Properties

For *dynamic values* and *conditional events*, the prefix for combo switches is `device.combo_switches.<name>`.

state String which reflects what state this combo switch is in. Options will be one of the following: *inactive*, *both* or *one*.

Related How To guides

Todo: TODO

Related Events

- *(combo_switch)_(state)*
- *flipper_cancel*

Extra Balls

Related Config File Sections

<i>extra_balls:</i>

MPF has support for extra balls. Extra balls in MPF are “named”, and they’re tracked so that (by default) each extra ball can only be awarded once. You can configure as many different extra balls as you want, each with different settings that tie into the events that award them.

The extra ball functionality is fairly basic at the moment, but we have plans to add things like maximum number of extra balls, settings to enable or disable extra balls, settings to award points instead of extra balls, etc.

Related How To Guides
TODO

Related Events
NONE (We need to add some

High Scores

Related Config File Sections
<i>high_score:</i>

MPF includes support for high scores which is where players can enter their names (or initials) when they’ve achieved a high score. Features include:

- Set any player variable as a high score option. So in addition to score you could set high score entries for loops, ramps, aliens destroyed, etc.
- Set how many of each high score type are tracked (Top 5 for high scores, Top 3 for loops, Top 1 for aliens, etc.)
- Set what each “award name” is called. (The highest score is “GRAND CHAMPION,” the second highest score is “HIGH SCORE 1”, the highest loop score is “MAJOR LOOPER”, etc.)
- How many characters a player can enter for their name.
- A list of valid characters the player can choose from
- The layout of the display for entering their names and show their rewards.
- Events for high score awards and entry, so you can configure high score entry screens.

Related How To Guides
TODO

Related Events
TODO

Logic Blocks

MPF config files include the concept of “logic blocks” which let you perform logic when certain events occur. Logic blocks can be thought of as the “glue” that ties together all the different shows, shots,

achievements, and other parts of your game logic.

There are three types of logic blocks in MPF:

counters Count the number of times an event happens, and when a certain number is hit, a “complete” event is posted.

accruals Watch for several different events to occur, and once they all do (no matter what order they happen in), a “complete” event is posted.

sequences Watch for several different events that need to occur *in a specific order*, and once they do, a “complete” event is posted.

Logic blocks can be configured to store their state in player variables, meaning that each logic block will remember where it was from ball-to-ball.

Logic blocks can be added to modes, and they can have events to enable, disable, and reset them.

To help you understand how logic blocks might be used, here are some real world examples from *Attack from Mars* (if we were building that game in MPF):

- A counter logic block can count the number of times a pop bumper is hit, and then when it hits a certain number, it posts an event to start a “Super Jets” mode.
- A counter can be used to track the three hits to the force field that are needed to lower it.
- A counter can be used (along with a timer) to track combos
- An accrual can be used in the Martian Attack mode to track all 4 of the martians being hit

Counter Logic Blocks

“Counters” are *logic blocks* that track the number of times a certain event happens towards the progress of a completion goal.

Examples include:

- Hit a target (or shot) X number of times to advance.
- Hit pop bumpers 75 times to start a Super Jets mode.
- Counting the number of combos made
- Keeping track of a bonus multiplier (maybe you use the shot group lane completion event to count progress towards the bonus multiplier, but you configure the max count to be 6, and then if it’s hit again, you award an extra ball).

You can use optional parameters to specify whether multiple occurrences in a very short time window should be grouped together and counted as one hit, the counting interval, and whether this counter counts up or down.

Here’s an example of a counter you could use to track progress towards super jets:

```
logic_blocks:
  counters:
    super_jets:
      count_events: sw_pop
      events_when_hit: pop_hit
      starting_count: 75
      count_complete_value: 0
```



```
direction: down
events_when_complete: super_jets_start
```

And here’s the logic block we use for the *Addams Family mansion awards* to make sure the mansions is initialized only once per game:

```
logic_blocks:
  counters:
    initialize_mansion:
      count_events: mode_chair_lit_started
      events_when_complete: initialize_mansion
      count_complete_value: 1
      persist_state: true
```

Settings

The structure of counter logic blocks is like this:

```
logic_blocks:
  counters:
    the_name_of_this_logic_block:
      <settings>
    some_other_logic_block:
      <settings>
    a_third_logic_block:
      <settings>
```

Note that the actual name of the logic block doesn’t really matter. Mainly it’s used in the logs.

count_events:

This is an event (or a *list of events*) that, when posted, will increment or decrement the count for this Counter.

Note that if you include multiple events in this list, *any* one of the events being posted will cause the hit count to increase. If you want to track different kinds of events separately, use an *Accrual* or *Sequence* Logic Block instead.

This setting is required.

count_complete_value:

When the Counter exceeds (or gets below if you’re counting down) this value, it will post its “complete” event and be considered complete.

Default is None.

Note that you can use a *dynamic value* for this setting.

multiple_hit_window:

This is an *MPF time value string* that will be used to group together multiple *count_events* as if they were one single event. So if you have `multiple_hit_window: 500ms` and you get three hit events 100ms apart, they will all count as one hit.

Note that subsequent hits that come in during the time window do not extend the time. So with the 500ms `hit_window` from above, the first hit counts and sets the timer, another hit 300ms later won't count, but a third hit 300ms after the second (and 600ms after the initial hit) will count (and it will set its own 500ms timer to ignore future hits).

Default is 0 (which means all hits are counted).

count_interval:

Specifies the numeric count change is for each hit. In other words, this is how much is added or removed from the count with each hit. Default is 1, but you can make it whatever you want if you want your count to increase by more or less than one whenever a count event occurs. You could use this, for example, in a mode to create a counter that tracks the value of a shot. Maybe it starts at 2,000,000, but each shot a playfield standup increases the value by 250,000.

Default is 1.

direction:

This is either up or down and specifies whether this counter counts up or counts down.

Default is up.

starting_count:

This is the starting value of the Counter and the value it goes back to when it's reset. Default is zero. If you're configuring a counter with `direction: down`, you'll want to also set this to something more than zero.

Default is 0.

Note that you can use a *dynamic value* for this setting.

player_variable:

By default, the current "state" (or progress) of sequence logic blocks are stored in a *player variable* called `<counter_name>_count`. For example, a logic block called "logic_block_1" would store its state in a player variable called `logic_block_1_count`.

However, you can use the `player_variable:` setting to change this to any player variable you want.

Making this change doesn't really affect anything other than the name of the variable. It's just for convenience if you prefer a different name.

Note that this player variable stores the count of this logic block in a numeric value that represents what the current count value is. In other words, when a sequence logic block is just started or reset, the player variable tracking it is set to 0. Then that increases by one as each step is complete.

You can easily use it in a text widget to show the number of combos complete, or the number of pop bumper hits required for super jets, etc.

persist_state:

Boolean setting (yes/no or true/false) which controls whether this logic block remembers where it was from ball-to-ball. If False, then this logic block will reset itself whenever a new ball starts.

Note that logic block state is always maintained on a per-player basis, regardless of what this setting is configured for.

Default is False.

reset_on_complete:

True/False (or Yes/No) which controls whether this logic block resets itself once it completes. This just resets the current value or progress. It does not change the enabled or disabled state.

Default is True.

disable_on_complete:

True/False (or Yes/No) which controls whether this logic block disables itself once it completes. This does not reset the current value.

Default is True.

Events posted by this logic block

You can enter a list of one (or more) events that will be posted when certain things happen to this logic block. Enter multiple events in *MPF list format*.

events_when_hit: Event(s) posted when this logic block is “hit”, meaning that one of the sequence events, accrual events, or count events was just posted and advanced this logic block’s state.

Note that the event *logicblock_(name)_hit* will always be posted, regardless of whether you have anything set here.

events_when_complete: List of one (or more) events which, when posted, will

Note that the event *logicblock_(name)_complete* will always be posted, regardless of whether you have anything set here.

Control Events

The following settings are used to configure events that will change the state of this logic block. Note that each of these can be one or more events.

You can list multiple events in the *events list format* which means you can specify delay times where the logic block will delay its enabling until the time passes.

enable_events: Event(s) that will enable this logic block.

A logic block must be enabled to track hits, progress, and to post events.

If you don't have any `enable_events` listed, then the logic block will automatically be enabled when the player's ball starts.

Default is None.

disable_events: Event(s) that will disable this logic block.

A logic block must be enabled to track hits, progress, and to post events.

Default is None.

reset_events: Event(s) that will reset this logic block back to its original value. This has no effect on the enabled/disabled state of the block.

Note that there are also `reset_on_complete:` and `persist_state:` settings which also affect how and when the logic block is reset.

You can reset a logic block regardless of whether it's enabled.

Default is None.

restart_events: List of one (or more) events which, when posted, will restart this logic block. A restart is a reset, then an enable, combined into a single action.

Default is None.

Accrual Logic Blocks

"Accruals" are a type of *Logic Block* where you can trigger a new event based on a series of one or more other events.

Accruals are almost identical to *Sequence Logic Blocks*, the only difference being that the steps in an Accrual Logic Block can be completed in any order, and the steps in a Sequence Logic Block must be completed in the specific order they're listed.

An example might be if you have 3 different things which need to happen in your machine, and when they're all complete, some other event is posted which kicks off some kind of award mode.

You would use an accrual if these 3 events can happen in any order. If they need to happen in a specific 1-2-3 sequence, then you would use a *sequence* logic block instead. (And if you just need the same event to happen three times, then you would use a *counter* logic block instead.

For example, let's say you had a mode where you wanted three shots to be hit, in any order, and when they were all hit, you lit another shot. You'd use an accrual logic block like this:

```
logic_blocks:
  accruals:
    name_of_my_logic_block:
      events:
        - shot1_hit
        - shot2_hit
        - shot3_hit
      events_when_complete: enable_winning_shot
```

There are much more settings (as you'll see below), but the basic logic block above (which is called "name_of_my_logic_block") will watch for the events `shot1_hit`, `shot2_hit`, and `shot3_hit` to be posted.

Once all three of them have been posted once, this logic block will post an event called *enable_winning_shot* which you can use to play a show, light some other shot, play a sound, award points, etc.

Again, since this is an accrual logic block, those three events can be happen in any order. If one of them is posted twice, that's fine. It doesn't count as one of the other events nor does it "undo" the fact that it was hit.

Settings

The structure of accrual logic blocks are like this:

```
logic_blocks:
  accruals:
    the_name_of_this_logic_block:
      <settings>
    some_other_logic_block:
      <settings>
    a_third_logic_block:
      <settings>
```

Note that the actual name of the logic block doesn't really matter. Mainly they're used in the logs.

events:

The events section of an accrual logic block is where you define the events this logic block will watch for in order to make progress towards completion.

The real power of logic blocks is that you can enter more than one event for each step, and *only one* of the of the events of that step has to happen for that step to be complete.

Another way to look at it is that there's an *AND* between all the steps. For the Accrual to complete, you need Step 1 *AND* Step 2 *AND* Step 3. But since you can enter more than one event for each step, you could think of those like *OR*s*. So you have Step 1 (event1 **OR* event2) *AND* Step 2 (event3) *AND* Step 3 (event4 *OR* event5), like this:

```
logic_blocks:
  accruals:
    events:
      - event1, event2
      - event3
      - event4, event5
```

It might seem kind of confusing at first, but you can build this up bit-by-bit and figure them out as you go along.

You can enter anything you want for your events, whether it's one of MPF's built-in events or a made-up event that another logic block posts when it completes. (This is how you chain multiple logic blocks together to form complex logic.)

For example:

```
logic_blocks:
  accruals:
```



```
logic_block_1:
  events:
    - event1
    - event2
    - event3
    - event4
    - event5
  events_when_complete: logic_block_1_done
logic_block_2:
  events:
    - event1, event2, event3
    - event4
    - event5
  events_when_complete: logic_block_2_done
```

In the example above, there are two logic blocks. The first one just has five steps that need to complete (in any order since we're dealing with accrual logic blocks), and each step only has one event that will mark it as complete. So basically any of those five events 1-5 can be posted in any order, and then *logic_block_1_done* will be posted.

In the second example, if event 1, 2, or 3 is posted, that will count for step 1, and then both events 4 and 5 need to be posted for steps 2 and 3. (Again, in any order.)

So in the second one, you could get event4, event2, then event5 posted, for example, and that will lead to *logic_block_2_done* being posted.

Note that you can have two logic blocks with the same events at the same time, and MPF will track the state of each logic block separately. So in the above config with those two logic blocks, if the events were posted in the order event2, event3, event4, then event5, that would complete logic block 2. Then later if event1 was posted, that would complete logic block 1.

player_variable:

By default, the current "state" (or progress) of accrual logic blocks are stored in a *player variable* called *<accrual_name>_status*. For example, a logic block called "logic_block_1" would store its state in a player variable called *logic_block_1_status*.

However, you can use the `player_variable:` setting to change this to any player variable you want.

Making this change doesn't really affect anything other than the name of the variable. It's just for convenience if you prefer a different name.

Note that this player variable stores the state of this logic block in an internal list that's not easily accessible for text display purposes on a slide. If you want to display status or progress on a slide, you can use a combination of the logic block events or an event player along with slide or widget player entries to show whatever messages you want.

persist_state:

Boolean setting (yes/no or true/false) which controls whether this logic block remembers where it was from ball-to-ball. If False, then this logic block will reset itself whenever a new ball starts.

Note that logic block state is always maintained on a per-player basis, regardless of what this setting is configured for.

Default is False.

reset_on_complete:

True/False (or Yes/No) which controls whether this logic block resets itself once it completes. This just resets the current value or progress. It does not change the enabled or disabled state.

Default is True.

disable_on_complete:

True/False (or Yes/No) which controls whether this logic block disables itself once it completes. This does not reset the current value.

Default is True.

Events posted by this logic block

You can enter a list of one (or more) events that will be posted when certain things happen to this logic block. Enter multiple events in *MPF list format*.

events_when_hit: Event(s) posted when this logic block is “hit”, meaning that one of the sequence events, accrual events, or count events was just posted and advanced this logic block’s state.

Note that the event *logicblock_(name)_hit* will always be posted, regardless of whether you have anything set here.

events_when_complete: List of one (or more) events which, when posted, will

Note that the event *logicblock_(name)_complete* will always be posted, regardless of whether you have anything set here.

Control Events

The following settings are used to configure events that will change the state of this logic block. Note that each of these can be one or more events.

You can list multiple events in the *events list format* which means you can specify delay times where the logic block will delay its enabling until the time passes.

enable_events: Event(s) that will enable this logic block.

A logic block must be enabled to track hits, progress, and to post events.

If you don’t have any *enable_events* listed, then the logic block will automatically be enabled when the player’s ball starts.

Default is None.

disable_events: Event(s) that will disable this logic block.

A logic block must be enabled to track hits, progress, and to post events.

Default is None.

reset_events: Event(s) that will reset this logic block back to its original value. This has no effect on the enabled/disabled state of the block.

Note that there are also `reset_on_complete:` and `persist_state:` settings which also affect how and when the logic block is reset.

You can reset a logic block regardless of whether it's enabled.

Default is None.

restart_events: List of one (or more) events which, when posted, will restart this logic block. A restart is a reset, then an enable, combined into a single action.

Default is None.

Sequence Logic Blocks

“Sequences” are a type of *Logic Block* where you can trigger a new event based on a series of one or more other events that are first posted in a specific order.

Sequences are almost identical to *Accrual Logic Blocks*, the only difference being that the steps in an Accrual Logic Block can be completed in any order, and the steps in a Sequence Logic Block must be completed in the specific order they're listed.

An example might be if you have to hit four shots in a specific order to complete a mode, like this example from the World Tour mode of *Brooks 'n Dunn*:

```
logic_blocks:
  sequences:
    finish_world_tour:
      events:
        - shot_north_america_hit
        - shot_south_america_hit
        - shot_europe_hit
        - shot_australia_hit
      events_when_complete: wt_done
```

The example above has a single sequence logic block called “`finish_world_tour`”. When it's enabled, it starts watching for the event `shot_north_america_hit` to be posted. Once it's posted, then it starts watching for the event `shot_south_america_hit` to be posted. At this point, if the europe or australia event is posted, it doesn't matter because this is a “sequence” logic block and the events have to happen in order. So this logic block will just sit there waiting for the current event only to be posted, and then once it is, it moves on, and any posted before or after are just ignored.

Once all four events have been posted in order, the event `wt_done` is posted which you can use to stop the mode or add a score or play a show or whatever you want.

Settings

The structure of sequence logic blocks is like this:

```
logic_blocks:
  sequences:
    the_name_of_this_logic_block:
      <settings>
    some_other_logic_block:
```



```
<settings>
a_third_logic_block:
<settings>
```

Note that the actual name of the logic block doesn't really matter. Mainly they're just used in the logs.

events:

The events section of a sequence logic block is where you define the events this logic block will watch for in order to make progress towards completion.

The real power of logic blocks is that you can enter more than one event for each step, and *only one* of the of the events of that step has to happen for that step to be complete.

Another way to look at it is that there's an *AND THEN* between all the steps. For the Sequence to complete, you need Step 1 *AND THEN* Step 2 *AND THEN* Step 3. But since you can enter more than one event for each step, you could think of those like *OR*'s. *So you have Step 1 (event1 *OR event2) AND THEN Step 2 (event3) AND THEN Step 3 (event4 OR event5)*, like this:

```
logic_blocks:
  sequences:
    events:
      - event1, event2
      - event3
      - event4, event5
```

It might seem kind of confusing at first, but you can build this up bit-by-bit and figure them out as you go along.

You can enter anything you want for your events, whether it's one of MPF's built-in events or a made-up event that another logic block posts when it completes. (This is how you chain multiple logic blocks together to form complex logic.)

For example:

```
logic_blocks:
  sequences:
    logic_block_1:
      events:
        - event1
        - event2
        - event3
        - event4
        - event5
      events_when_complete: logic_block_1_done
    logic_block_2:
      events:
        - event1, event2, event3
        - event4
        - event5
      events_when_complete: logic_block_2_done
```

In the example above, there are two logic blocks. The first one just has five steps that need to complete (in 1-2-3-4-5 exact order since we're dealing with sequence logic blocks), and each step only has one event that will mark it as complete.

In the second example, if event 1, 2, or 3 is posted, that will count for step 1, and then both events 4 and 5 need to be posted for steps 2 and 3. (Again, in order, so event 1, 2, or 3 has to be posted before the logic block will even start looking for event 4.)

So in the second one, you could get event2, event4, then event5 posted, for example, and that will lead to *logic_block_2_done* being posted.

Note that you can have two logic blocks with the same events at the same time, and MPF will track the state of each logic block separately. So in the above config with those two logic blocks, if the events were posted in the order event2, event3, event4, then event5 were posted, that would complete logic block 2, then later if event1 was posted, that would complete logic block 1.

player_variable:

By default, the current “state” (or progress) of sequence logic blocks are stored in a *player variable* called *<sequence_name>_step*. For example, a logic block called “logic_block_1” would store its state in a player variable called *logic_block_1_step*.

However, you can use the *player_variable:* setting to change this to any player variable you want.

Making this change doesn’t really affect anything other than the name of the variable. It’s just for convenience if you prefer a different name.

Note that this player variable stores the state of this logic block in a numeric value that represents which step is complete. In other words, when a sequence logic block is just started or reset, the player variable tracking it is set to 0. Then that increases by one as each step is complete.

persist_state:

Boolean setting (yes/no or true/false) which controls whether this logic block remembers where it was from ball-to-ball. If False, then this logic block will reset itself whenever a new ball starts.

Note that logic block state is always maintained on a per-player basis, regardless of what this setting is configured for.

Default is False.

reset_on_complete:

True/False (or Yes/No) which controls whether this logic block resets itself once it completes. This just resets the current value or progress. It does not change the enabled or disabled state.

Default is True.

disable_on_complete:

True/False (or Yes/No) which controls whether this logic block disables itself once it completes. This does not reset the current value.

Default is True.

Events posted by this logic block

You can enter a list of one (or more) events that will be posted when certain things happen to this logic block. Enter multiple events in *MPF list format*.

events_when_hit: Event(s) posted when this logic block is “hit”, meaning that one of the sequence events, accrual events, or count events was just posted and advanced this logic block’s state.

Note that the event *logicblock_(name)_hit* will always be posted, regardless of whether you have anything set here.

events_when_complete: List of one (or more) events which, when posted, will

Note that the event *logicblock_(name)_complete* will always be posted, regardless of whether you have anything set here.

Control Events

The following settings are used to configure events that will change the state of this logic block. Note that each of these can be one or more events.

You can list multiple events in the *events list format* which means you can specify delay times where the logic block will delay its enabling until the time passes.

enable_events: Event(s) that will enable this logic block.

A logic block must be enabled to track hits, progress, and to post events.

If you don’t have any *enable_events* listed, then the logic block will automatically be enabled when the player’s ball starts.

Default is None.

disable_events: Event(s) that will disable this logic block.

A logic block must be enabled to track hits, progress, and to post events.

Default is None.

reset_events: Event(s) that will reset this logic block back to its original value. This has no effect on the enabled/disabled state of the block.

Note that there are also *reset_on_complete:* and *persist_state:* settings which also affect how and when the logic block is reset.

You can reset a logic block regardless of whether it’s enabled.

Default is None.

restart_events: List of one (or more) events which, when posted, will restart this logic block. A restart is a reset, then an enable, combined into a single action.

Default is None.

Integrating Logic_Blocks and Shows

Logic_blocks can be flexibly integrated with shows using the *(name)_updated* event. It is posted on every state change (i.e. when a counter is incremented) and when *logic_blocks* are restored (on mode restart). This means that the event may be posted more than once and all handlers should be

idempotent (i.e. that you can execute them more than once without changing state after the first time). Therefore, this event should not be used for scoring. However, it works well to control shows, lights, slides and restore them on the next ball.

```
logic_blocks:
  counters:
    my_counter:
      count_events: my_count_event
      starting_count: 0
      count_complete_value: 3

  show_player:
    logicblock_my_counter_updated{value == 0}:
      my_show_initial:
        key: my_counter_show # this is to remove the previous show from the same player
    logicblock_my_counter_updated{value == 1}:
      my_show_first_hit:
        key: my_counter_show # this is to remove the previous show from the same player
    logicblock_my_counter_updated{value >= 2}:
      my_show_final:
        key: my_counter_show # this is to remove the previous show from the same player
```

Every time `my_counter` is updated (or restored) it will post `logicblock_my_counter_updated`. Depending on the value of `my_counter` either `my_show_initial` (value is 0), `my_show_first_hit` (value is 1) or `my_show_final` (value is 2 or 3) are shown. All `show_players` have the same key so they will stop any other show playing with the same key.

Match

todo

Editorial about why we think match is a bad idea

Note that match only makes sense if your machine is set for credit play

Modes

Game modes are a big part of pinball programming and a big part of MPF, so it's worth taking an in-depth look at what they are and how they work.

Related Config File Sections
<i>mode:</i>
<i>modes:</i>

As a pinball player, you're probably familiar with the concept of "modes." Most modern machines have lots of different modes, and typically you complete various modes throughout a game on your way to the wizard mode. Many machines have lights on the playfield that show what modes have been completed so far. The player might need to do something to light a "start mode" shot, and then when that shot is made, the mode starts. Then the mode runs for awhile, and while it's running there's typically some kind of sub-goal. (Hit as many standups as you can, shoot both ramps, get as many pop bumper hits as possible, etc.) Some modes run for a predetermined amount of time (e.g. 30 seconds

or until the ball drains), some modes are multiball and stop when there's only one ball left, some modes run until the ball ends, some modes run until you complete the mode's objectives, and some modes just sort of run forever.

MPF takes a slightly different approach to modes. In MPF, modes are used for almost everything—a lot more than just “in game” modes. For example, the attract mode is a “mode” in MPF, as is the bonus processing, the high score name entry, and lots of other things that you wouldn't think of as a traditional game mode. In fact even the “game” itself is a mode in MPF! MPF includes many built-in modes (that you can use outright or customize), and you can create your own modes as needed.

How modes work in MPF

To add a mode to your MPF machine configuration, you create a folder called *modes* in your machine's folder. Then inside there, you create subfolders for each mode in your machine, like this.

In your game, you might have dozens (or even hundreds) of mode folders. Each of your modes folders is almost like a mini-MPF configuration that's only active during that mode. You can have subfolders in each mode folder for game assets, config files, and code that only apply to that mode, like this:

Each of a mode's subfolders follows the same structure as your machine folder in general. The *config* folder holds YAML configuration files, the *shows* folder holds show files, the *sounds* folder contains audio files, the *animations* folder contains animations, etc. (Note that not every type of folder will be in every mode. If a mode doesn't have a specific type of content, then you don't need to include the folder for it.) The idea is that each subfolder holds everything that mode needs, and everything in a mode's folder only applies to that specific mode. For example, in a mode's config file, you can add several types of configuration entries (as detailed in the configuration file reference), that only apply when that mode is active, including:

- shows
- slides
- multiballs
- ball locks
- sounds
- shows
- scoring
- etc.

Again, anything that's specified in a mode's configuration file is only active while that mode is active. So if you have a mode called “multiball” with the following entry in that mode's config file:

```
scoring:
  right_ramp_hit:
    score: 50000
```

In that case the *right_ramp_hit* shot event will only award the points when that multiball mode is running. When it stops, that scoring configuration is removed. (You can also configure certain events to be “blocked” from propagating down to lower-priority modes. More on that in a bit.)

Machine-wide versus mode-specific folders and configurations

You might have noticed that many of the settings you add to mode-specific configuration files are also valid settings for the machine-wide configuration files which can exist in `your_machine_folder/config/config.yaml` file. So what's the difference between the two? If you configure a setting in a machine-wide configuration file, then that setting will be available at all times in your machine. If you configure a setting in a mode-specific configuration file, then that setting will only apply when that mode is active. The same is true for asset files (in your images, animations, movies, sounds, or shows folder). For example, if you put a sound file in `your_machine_folder/sounds` folder, then that sound will be available to any mode in your machine. If you put it in the *sounds* folder under a specific mode, then that sound file will only be available to that mode. You can even configure assets to automatically load when a mode starts and unload when a mode ends—a feature that is necessary on memory-limited hardware platforms like the BeagleBone Black. The reason MPF's mode system was built this way is so that each mode is self-contained. This is especially useful in situations where more than one person is working on a particular game. You can think of each mode's folder as a mini self-contained MPF environment, as each mode will have its own files and configuration. This also makes it easier to keep track of which modes use which files.

When to use modes

As you read this, it's natural to think of MPF's modes like game modes, and certainly that's a big part of how they're used. But there is no limit to the number of modes that can be active at any one time (and it doesn't negatively affect performance to have dozens of modes running at once), so when you start programming your game you'll probably end up breaking your game logic into lots of little modes.

For example, skill shot should be implemented as a mode. You could create a mode called *skill_shot* that loads when a new player is up, and while it's active it can light certain shots and award points and play light shows and animations associated with the skill shot. You can also setup a timer that automatically starts running when the ball is plunged, and then when the timer ends, you can configure it to unload the skill shot mode. (You would also configure the skill shot mode to stop and unload as soon as the skill shot is made.) You might also have modes which track combos, progress towards ball locks, or really anything else you want.

The key with modes in MPF is to understand that they're more than game modes. You'll create lots and lots of them for all sorts of things. (Basically anything you want which temporarily changes switches, rules, scoring, or any type of device behavior will be a mode in MPF.)

Adding your modes to your machine configuration

If you want to add a mode to your game, you need to add a `modes:` section to your machine configuration file and then create an entry for each mode (by listing the folder), like this: (It's important to have the dash in front of each line.)

```
modes:
- skillshot
- base
- both_ramps_made
- gun_fight
- multiball
- skillshot
- watch_tower
```

The reason for this is that you might have some modes in your *modes* folder that you're working on that aren't complete yet, or you might want to build different sets of configuration files that use different modes. So you have to list all the modes that you want to use in your machine config file for MPF to read in those modes.

Working with mode-specific config files

We already mentioned that each mode in MPF is really like a full “mini” instance of MPF with settings and assets that only apply to that specific mode. So just like the root MPF config, you create a config subfolder in each mode's folder, and then you put a YAML configuration file in that mode's *config* folder that holds all the config settings for that mode. Recall that the default config file name for your machine-wide configuration is a file called *config.yaml*. When you setup a mode's specific config file, you do so by naming the file *<mode_name>.yaml*. (So this file would be *<your_machine_file>/modes/<mode_name>/config/<mode_name>.yaml* file.)

For example, the configuration file for a skill shot mode might be *<your_machine_file>/modes/skillshot/config/skillshot.yaml*. The reason each mode's config file is based on the mode name rather than just being called *config.yaml* is simply for the convenience of the programmer. Our experience is that when we're working on a game, we typically have lots of tabs open in our file editor, and it's really confusing if all the tabs are named *config.yaml*! So we made it so each mode's config file is based on the mode name instead. In each mode's config file, you can add an entry called *mode:* which holds settings for the mode itself. Typically this is just a list of MPF events that will cause the mode to start and stop, as well as the priority the mode runs at, the name of the mode, and whether the mode has any custom Python code that goes with it. (Full details of this are in the *mode:* section of the configuration file reference.)

Starting and stopping modes

Modes stop and start based on standard MPF events. For example, if you want a mode to run whenever a ball is in play, you'd add *ball_starting* to the mode's start events list, and you wouldn't specific a stop event. If you want a mode to automatically stop when a timer expires, you'd add the name of the event that's posted when the timer ends to the mode's stop events list.

Mode priorities

When you set up the configuration for a mode (via the *mode:* section of that mode's *config/<mode_name>.yaml* file, you can optionally specify a priority for that mode. Specifying a priority for a mode is useful when you have more than one mode running and you want to control how all the running modes interact with each other.

For example, you can configure scoring events so they “block” lower level modes which have score configured for the same event. So you might have a base game mode which scores 10k points for a ramp shot, but then in one particular mode you might want to make the ramps worth 100k points. To do this you would add the scoring setting for 100k to your special mode, and then you'd run that mode at a higher priority than your base game mode and configure the scoring for that event to block the scoring from the lower mode. (Otherwise you'd get both scoring events and a ramp shot would grant 110k points.) Whether you configure a scoring event to block or not is optional, and you can specify it on an individual basis per scoring event. (And in many case you very well might want to score both events from both modes.)

The mode priorities also affect the priorities of things like all display widgets and slides. For example, your base mode might play an animation and a light show when a ramp shot is made in the base game mode, but when your special higher mode is running you might want to play a different slide and a different light show. So by specifying the special mode to run at a higher priority, it will get priority access to the display and lights. (Again you can configure this on a setting-by-setting basis, because there are plenty of times where you might actually want the lower-priority shows to play even when a higher priority mode is running.)

Note: In MPF prior to v0.20, there was the concept of “machine” modes and “game” modes. Starting with MPF v0.20, those have been combined, and they’re just called *modes*. MPF comes with its own built-in modes that will be mixed together with your own machine-specific modes. For example, MPF includes modes for *attract* (priority 10) and *game* (priority 20) which are responsible for the fundamentals of running the attract and game modes.

Using modes as game logic

Using “modes” to implement game logic

One thing I found is that I tend to use modes as a sort of “super” logic block. For example, the Brooks & Dunn rules have a “manager’s choice” shot that leads to a ball device. When the shot is lit, one of three things happens depending on what else is going on (one for base game mode, another for when multiball is active, and a third which is a timed mode). The shot may be lit or unlit in any of those three scenarios, and the action I’m talking about should only happen when it’s lit, otherwise it just scores some points and kicks out the ball.

I realized pretty quickly that the easiest way to handle this is to create a mode called “managers_choice_lit” which is used to light the shot regardless of what else is happening. When that mode starts, it enables the shot, turns on the light, shows a slide that says the shot is lit, etc. I created a start event “light_managers_choice” which is easy to post from wherever else I need in the game to light the shot.

Then in order to handle the various chains of events that happen when that shot is actually made, I created three more modes:

- managers_choice_base (priority 301)
- managers_choice_timed (priority 302)
- managers_choice_multiball (priority 303)

Each of these modes looks for the “managers_choice_lit” hit (shot) event and then will do their award thing. What’s cool is they also each block the shot from the lower down modes. This means that these shots can be stacked and running in any various combination.

So the managers_choice_base mode is running at all times (with a start event of ball_starting). That’s safe to run because it doesn’t do its award action unless the managers choice lit hit event happens, and that shot is enabled in the managers_choice_hit mode. In other words, managers_choice_base mode can be running at all times, but it will only award the shot if the managers_choice_lit mode is running.

Then if managers_choice_timed or managers_choice_multiball is running, they also do their award thing based on the managers_choice lit hit shot event, so they also can run any time but will not award the shot unless the managers_choice_lit mode is running.

And since those two higher modes block the shot from lower modes, this means that I don't need complicated if/then logic to figure out which of the three award options should be awarded when the shot is lit and hit.

And since the `managers_choice_hit` mode acts as an on/off switch for whether the shot will be awarded, this means that I can safely start the `managers_choice_timed` mode any time any other timed mode is running, and I can start the `managers_choice_multiball` mode anytime multiball play is going on, and they'll each only do their award if the base `managers_choice_lit` is running and the shot is made.

Related How To Guides
<i>Creating your first game mode</i>

Related Events
<i>mode_(name)_started</i>
<i>mode_(name)_starting</i>
<i>mode_(name)_stopped</i>
<i>mode_(name)_stopping</i>
<i>clear</i>

Built-in Modes

MPF includes several "built-in" modes which are ready to use in your game. Some of them are used automatically, and some require that you add some config sections and options to your machine. Click on each for details:

Creating your own modes

Our step-by-step tutorial walks you through creating your own game modes. We just include this page on creating your own modes so you don't read the list of built-in modes and think that's all MPF can do. :)

Also if you haven't read the overview of [*how modes work in MPF*](#), do that now.

Attract (mode)

MPF includes a built-in attract mode which is what runs the machine when a game is not in progress. It starts when either the `game_ended` or `reset_complete` event is posted, and it stops when the `game_start` mode is posted. The attract mode runs at priority 10.

The code and configuration for the built-in attract mode is in the `mpf/modes/attract` folder. It's automatically added to the list of modes in the `modes:` section of your machine-wide config based on settings in the `mpfconfig.yaml` baseline configuration file.

The attract mode is responsible for many things, including:

- Watching for the start button to be pressed & released to kick off the `request_to_start_game` event

- Recording how long the start button was held in for in order to take different actions based on different times. (For example, maybe pressing the start button normally starts a regular game, and doing a long-press lets the player login with a custom player profile.)
- Recording what other buttons were active when the start button is pressed. (Maybe holding the right flipper button and pushing start enables tournament mode.)

You can completely customize and extend the attract mode. In most cases that's as simple as adding a config file for the attract mode to your game folder and then configuring light and display shows to play. See the tutorial for details on how to do this.

Game (mode)

MPF includes a built-in mode called *game* which is responsible for actually running a game in MPF. It starts when a game is started from the attract mode, and it stays running all the way through the entire game, finally stopping again when the game ends and the attract mode starts again.

The code and configuration for the built-in game mode lives in the `mpf/modes/game` folder. It's automatically added to the list of modes in the `modes:` section of your machine-wide config based on settings in the `mpfconfig.yaml` baseline configuration file. The game mode runs at priority 20. It starts when the `game_start` event is posted, and it stops when the `game_ended` event is posted.

The game mode is responsible for many things, including:

- Tracking the number of balls in play. (Remember the number of balls in play is not necessarily the same as the number of live balls on the playfield that the ball controller tracks.)
- Watching for start button pushes to add additional players to the game.
- Restarting the game on a "long press" of the start button.
- Posting the `game_started`, `ball_starting`, `ball_ending`, `ball_ended`, `game_ending`, and `game_ended` events.
- Posting the events relating to multiplayer games.
- Handling ball drains and ending the current player's turn
- Rotating the players and starting the next player's turn
- Processing extra balls and handling shoot again

It's almost never necessary to override or change the behavior of the game mode. Typically anything you want to do to affect the game is done in additional modes you create. (And all the configuration for scoring, game modes, shots, etc. is done in a "base" game mode that runs per player as their turn starts.) See the tutorial for details.

Credits (mode)

MPF includes a complete credits mode that can be used to enable tracking credits and taking money. See the [How To: Add Coins & Credits](#) guide for details of how to set it up.

The credits mode is highly-configurable, including pricing per game, currencies, price tiering (\$0.50 for 1 credit, \$2.00 for 5, etc.), credit expiration, etc.

High score (mode)

MPF includes a built-in high score mode that can be used to track high scores, including letting players enter their names (or initials) and tracking different high score awards. (See the How To: High Scores guide for details).

You can use the config files to completely customize how the high scores work, including the number of scores to track, what you call each award (“GRAND CHAMPION”, “HIGH SCORE 1”, etc.) and what (and how many) awards you track (score, loops, aliens blasted, etc.).

The high score mode stores its high scores in `<your_machine_folder>/data/high_scores.yaml` file. It automatically reads them in when MPF boots to create machine variables that can be accessed from your game, and it automatically updates the high scores on disk when they change after a game ends.

Tilt (mode)

The MPF package includes built-in tilt mode that can be used to track manage tilt warnings, tilts, and slam tilts.

The tilt mode runs at priority 10,000 and automatically starts when MPF boots up. It never stops, even running while the attract mode is running. (This is because you want it to watch for slam tilts that reset the credits even when there’s not a game in progress.)

The tilt mode can use traditional mechanical tilts (plumb bobs, weighed switches, and rolling balls), or it can use accelerometers to determine G-forces and angle of the machine which can trigger tilts.

See the How To: Create a Tilt guide for details on how to use it in your machine.

Multiballs

Related Config File Sections
<i>multiballs:</i>
<i>multiball_locks:</i>

- [*Common Issues*](#)
- [*Monitorable Properties*](#)
- [*Related How To guides*](#)
- [*Related Events*](#)

MPF includes a *multiball* feature which can be used to automatically start and stop multiballs.

Each multiball in MPF has a separate name. There are several different types of multiballs (run until a single ball is left, timed multiballs, etc.) Multiballs can also be configured with multiball saves so that (for example) any balls lost in the first 15 seconds of a multiball are automatically re-launched back into play.

MPF also supports stacking of multiple multiballs at the same time.

Balls can be locked for multiball with the related [*Multiball Locks*](#) config section.

Common Issues

Why does MPF wait about 10s when adding balls to the playfield from the trough during a multiball?

When MPF adds a ball to the playfield the launcher waits until the ball is confirmed to be on the playfield. For the first ball this happens when a playfield switch is hit after the eject. However, this will not work with more than one ball on the playfield (e.g. during a multiball). In this case, the launcher will wait until its eject timeout passed (*eject timeouts in ball devices*) which defaults to 10s. Therefore, you need to tune eject_timeouts of your launcher to fix this issue.

Monitorable Properties

For *dynamic values* and *conditional events*, the prefix for multiballs is `device.multiballs.<name>`.

balls_added_live Numeric value of how many balls this multiball added into play.

balls_live_target Numeric value of how many balls this multiball is attempting to keep in play.

enabled Boolean (true/false) as to whether this multiball is enabled.

shoot_again Boolean (true/false) as to whether this multiball is in “shoot again” mode which means it’s attempting to keep live.

Related How To guides

- *How to create a multiball with a traditional ball lock*
- *How to create a multiball with a virtual ball lock*
- *How to create an “add-a-ball” style multiball*
- *How to create a multiball with a virtual ball lock*
- *How to create a multiball which uses multiple lock devices*

Related Events

- *multiball_(name)_ended*
- *multiball_(name)_lost_ball*
- *multiball_(name)_shoot_again*
- *multiball_(name)_shoot_again_ended*
- *multiball_(name)_started*

Multiball Locks

Related Config File Sections
<i>multiballs:</i>
<i>multiball_locks:</i>

- [Monitorable Properties](#)
- [Related How To guides](#)
- [Related Events](#)

New in version 0.33.

Multiball locks work in concert with multiball logic to “lock” balls for multiball. To use a multiball lock, you configure it for the ball device (or devices) that will be used to lock balls, and then when a ball enters one of those devices, the lock count is increased by one.

Multiball locks can be configured in one of four modes of operation:

virtual_only When a new ball is locked, the lock count is increased. Period. It does not matter how many physical balls are locked. Separate counts are maintained per player. This is usually the best option for locks in modern machines.

physical_only As the name implies, the number of balls locked is always the same as the physical number of balls in the lock. A new ball locked will increase the lock count for that player and lock the ball. However if another player “steals” one of the locked balls, then when the previous player starts their turn, the lock count is updated based on the physical balls locked. This is mostly for EM and early solid state machines where balls would be locked in different places on the playfield but the next player could steal them if the player who locked them didn’t get multiball started.

min_virtual_physical Similar to physical only except a player locking a ball will always increase the lock count even if that same ball is ejected again.

no_virtual MPF forgets everything when the player changes.

Ball locks are stored on a per-player basis and are NOT based on the number of balls that are physically contained in any ball devices.

When a ball is locked, a new ball will be added into play (from whichever ball device is tagged with the `ball_add_live` tag) unless the device that just received the locked ball is full, in which case the ball will be released from the device that the ball just entered instead.

Multiball locks can be enabled and disabled with events, so if you want to set up a scenario where a player must “re-light” the lock after each ball is locked, then you can use the event which is posted when a ball is locked as a disable event for this ball lock, and then use the event from some other shot or switch or logic block as an enable event to re-light the lock.

You can configure multiball locks for the total number of balls they should lock which will in turn post a “lock full” event which you can use to start a multiball. That multiball will release all the balls it can from the lock devices this multiball lock uses, and if it still needs more balls (maybe because you’re using a virtual lock or because a previous player emptied them out), then it will make up the difference by adding new balls from the ball device tagged with `ball_add_live`.

Monitorable Properties

For [dynamic values](#) and [conditional events](#), the prefix for multiballs is `device.multiballs.<name>`.

enabled Boolean (true/false) as to whether this multiball lock is enabled.

locked_balls The number of balls that are locked. Note that how this number is calculated varies depending on how the ball counting strategy is configured for this multiball lock.

Related How To guides

- [*How to create a multiball with a traditional ball lock*](#)
- [*How to create a multiball with a virtual ball lock*](#)
- [*How to create an “add-a-ball” style multiball*](#)
- [*How to create a multiball with a virtual ball lock*](#)
- [*How to create a multiball which uses multiple lock devices*](#)

Related Events

- [*multiball_\(name\)_ended*](#)
- [*multiball_\(name\)_lost_ball*](#)
- [*multiball_\(name\)_shoot_again*](#)
- [*multiball_\(name\)_shoot_again_ended*](#)
- [*multiball_\(name\)_started*](#)

How to create a multiball with a traditional ball lock

todo

How to create a multiball with a virtual ball lock

todo

How to create an “add-a-ball” style multiball

todo

How to create a multiball which uses multiple lock devices

todo

Player Variables

Related Config File Sections

<i>player_vars:</i>

MPF contains lots of features which make working with players easy including variables. If you are not a programmer, variables are just locations inside the computer's memory to store bits of information like numbers and text (aka strings). Programmers create variables to store and retrieve these bit of information for use in their programs. For example, You may want to create a player variable to store the number of times a bumper has been hit to award a bumper bonus.

Each player has "player variables" which are key/value pairs that are stored separately for each player.

Some simple examples of player variables include things like:

- number: The player's number (1, 2, etc.)
- score: The player's current score

There are two types of player variables that you can use; the default player variables provided by MPF and custom variables that you can create, update and reference.

Default Player Variables

There's a [Player Variables Reference](#) which lists the default player variables that MPF creates and uses.

MPF also uses player variables to keep track of all the built-in game logic elements that are tracked on a per-player basis, including achievement status, logic block states, extra balls, bonus, etc.

Custom Player Variables

You can also create your own custom player variables which can be called anything you want and can store anything you want. You can use them to track player's progress through the game, how many loops they've made, how many pop bumper hits they have, etc. See the [player_vars](#): documentation for details and examples.

Data types

If you are a programmer, you likely know what datatypes are. If you are not a programmer but want to create your own player variables, you'll need to know a little bit about datatypes. To make this really simple, you may want to store the name of the current mode so that you can display the mode name on the display. Since the name of the mode is a piece of text, you'll need to create a player variable of type "str" to denote a string of characters. Here are the data types available in MPF.

Datatype	Description
str	a string of textual characters
int	an integer, a basic number with no decimal point
float	floating point, a more precise number with decimal point

Examples:

```
player_vars:
  current_mode:
    initial_value: Trees Attack
    value_type: str
```



```
bumper_hits:
    initial_value: 0
    value_type: int
super_bonus_multiplier:
    initial_value: 1.25
    value_type: float
```

Player variables are essentially global in MPF, meaning that you can define them in config files and they are available to use in any location in your files. This makes them easy to use but also easy to introduce bugs or unintended consequences so be aware of every place that you use them if you are getting unanticipated results. A best practice would be to define all of your player variables in a common location such as the machine configuration file.

Setting Variables

MPF configuration files do not work with variables as easily as “real” programming languages. The primary method of changing a variable is by configuring the change you would like to make. In the current version of MPF (0.33), this is primarily done in the “scoring:” section of your mode.

```
scoring:
    # add 1 to bumper_hits
    bumper_1_active:
        bumper_hits: 1
```

The example below shows a player variable of type string being updated. A mode carousel (mode selection by the player) was used by the player to select a mode ladder (a set of modes played in a sequence similar to scenes in GhostBusters). The apostrophes are not required but allowed.

```
scoring:
    carousel_left_scoop_scene_selected:
        current_ladder:
            action: set
            string: 'Scene 1'
```

The example below shows a player variable being updated after a conditional event. In this case, the base mode has received an event indicated that a mode has been complete. The conditional event checks to see which mode ladder was in play and increments the custom player variable `ladder_scene_1` to indicate the progress towards completing the mode.

```
scoring:
    mode_is_complete{current_player.current_ladder=="Scene 1"}:
        ladder_scene_1: 1
```

Displaying Custom Variables

Displaying your custom player variables on a slide can be confusing in the current version of MPF (0.33). The example below shows a text widget that is displaying 3 variables on the main scoring screen of the base mode. The first two variables are of type “str” and the last variable is of type “int”. The “player” keyword seems to be a special way of expressing the current player and displaying an integer value.


```

slide_player:
  mode_base_started:
    widgets:
      - type: text
        text: (current_ladder) > (current_mode) > (player|ladder_scene_1)

```

Related How To Guides

TODO

Related Events

<i>player_(var_name)</i>

<i>player_add_request</i>

<i>player_add_success</i>

<i>player_turn_start</i>

<i>ball_save_(name)_saving_ball</i>

<i>player_turn_stop</i>

<i>multi_player_ball_started</i>

<i>single_player_ball_started</i>

Replays

todo

Timed Switches

Related Config File Sections

<i>timed_switches:</i>

New in version 0.33.

- *Monitorable Properties*
- *Related How To guides*
- *Related Events*

MPF includes functionality to manage “timed_switches” which are scenarios when a single switch is continuously active (or inactive, depending on the settings) for a set period of time.

A classic example of this is the flipper “cradling” where a player holds a flipper button in for a few seconds. In almost all modern machines, this is used to trigger a “player info” screen that shows the player’s score, how much bonus they have built up, high scores, etc.

Flipper cradling is also used to reset (and pause) the ball search timer, since a player could be holding a ball and drinking a beer, meaning no switch hits will happen, but the ball search should not start.

In fact MPF’s default config file (which is automatically used in all games) includes a `timed_switches:` section for flipper cradling and automatically creates *flipper_cradle* and *flipper_cradle_release* events (as long as you tag your flipper switches with *left_flipper* and *right_flipper*).

Note that timed switches are similar to, but not the same as *combo switches*.

Monitorable Properties

For *dynamic values* and *conditional events*, the prefix for timed switches is `device.timed_switches.<name>`.

active_switches List of switches that are currently active past the time that this `timed_switches:` section is set for.

Related How To guides

Todo: TODO

Related Events

- *flipper_cradle*
- *flipper_cradle_release*

Timers

Related Config File Sections
<i>timers:</i>

MPF config files include the concept of “timers” which you can use to count towards a specific event based on time. Timers can be configured to count up or down, at whatever interval you want, at any speed you want. You can use events to start, stop, pause, reset, or change their speed.

Timers post events with each “tick” which you can use to update the display, play sounds, etc. They also post events when they complete which you can use to stop a mode, play a show, etc.

Example uses of timers might include:

- Hurry up count down to make a shot (with variable score based on how much time is left).
- Timer to end a timed mode.
- A timer which ticks periodically to rotate a lit shot left or right.

- Etc.

The example config files section of the documentation contains [examples of timers in modes](#).

Related Events
<i>timer_(name)_complete</i>
<i>timer_(name)_paused</i>
<i>timer_(name)_started</i>
<i>timer_(name)_stopped</i>
<i>timer_(name)_tick</i>
<i>timer_(name)_time_added</i>
<i>timer_(name)_time_subtracted</i>

Shots

In MPF, a “shot” is a switch (or combination) of switches that the player shoots for. Examples include:

- A standup target, drop target, or rollover lane
- A ramp, loop, or orbit
- A toy, subway, or VUK

Most shots have lights or LEDs associated with them which are on, off, flashing, and/or certain colors to reflect what “state” the shot is in.

Broadly speaking, a shot is anything the player shoots at during a game. It could be a standup target, a lane, a ramp, a loop, a drop target, a pop bumper, a toy, etc.

You can read the [full shots documentation](#) for details, but the short version is that in MPF, you define switches (or a sequence of switches) as a “shot”. Then whenever that shot is made, MPF posts events which you can use to trigger scores, achievements, shows, etc.

Some shots are made up of a single switch (like a standup target). But you can also configure shots that are only considered to be hit based on series of switches that must be hit in the right order within a certain time frame. For example, you might have an orbit shot with three switches: *orbit_left*, *orbit_top*, and *orbit_right*. You could configure one shot called *left_orbit* that’s triggered when the switches *orbit_left*, *orbit_center*, and *orbit_right* are hit (in that order) within 3 seconds, and you could configure a second shot called *right_orbit* that’s triggered when the switches *orbit_right*, *orbit_center*, and *orbit_left* are hit within 3 seconds. (So, same switches, but two different shots depending on the order they’re hit.)

The beauty of using shots is that you just define all the switches and timing once, and then every time you want to use that shot in your game, you just need to work with the “right_orbit” shot and not have to worry about all the details of the switches and timing.

You can also configure different “states” for shots, e.g. “What state is that shot in?” That can be things like lit, unlit, complete, flashing, etc. You can also configure shows for each state (the unlit state means the light is off, flashing means that the light is flashing, etc.), and you can configure different scoring based on whether state the shot is in (1,000 points if unlit, 5,000 if lit, etc.). All of this is completely configurable.

You can also group multiple shots into “shot groups” and then do certain things when all the shots in the group are in the same state. For example, you could have three standup targets configured as

three separate shots that all start in the “unlit” state, but then once all three shots are advanced to the “complete” state, you could add 100,000 points and start another mode.

Shots are also integrated into MPF’s modes system, so you can configure a shot to do different things in different modes.

For example, a ramp shot might do nothing more than score 1,000 points in your base mode, but when the multiball mode is running, that same shot would score a jackpot. You can also configure whether notification of a shot being hit is passed down from one mode to the lower priority modes below it. (In the jackpot example we just mentioned, you probably just want to score the million points for the jackpot if that shot is made while the multiball mode is running and *not* score the 1,000 points for that shot from the base mode even though the base mode is still running under the multiball mode.

Grouping Shots for lane change, rotation, etc.

TODO

Shot Profiles

TODO

Skill Shot

Types of skill shots:

- Time based
- Hit some target before another target
- Super skill shot
- How to create a lane-change skill shot

TODO

Video Modes

TODO

Scoring

Related Config File Sections

<i>scoring:</i>

Scoring is commonly used to score points for the current player when a certain event is posted. This event could be a switch hit (i.e. for `s_your_switch` use the event `s_your_switch_active`).


```
scoring:
  s_your_switch_active:
    score: 100
```

Furthermore, you can add or set any other player or machine variable. Placeholders are available as well. See the [example config](#) for working examples.

Tilt

Tilt is a built-in mode. To enable it, just add the `tilt` mode to your machine config list of modes.

Tilt runs at all times, since the machine has to look for slam tilts while games are not running.

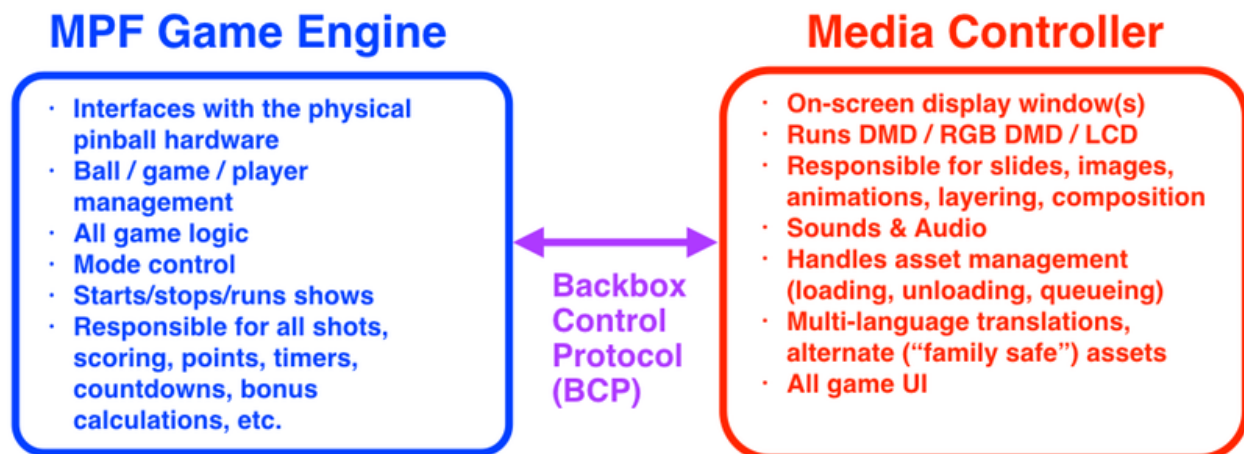
Talk about tilt throughs

Ball end events are posted immediately.

Media Controllers

One of the most important things to understand about the architecture of MPF is that the core MPF game engine is completely separate from the process that controls graphics and audio. We call the thing that handles graphics and audio a “media controller.” The game engine and media controller talk to each other via something called “BCP” which is a protocol we created for this purpose which stands for “Backbox Control Protocol”. (More details on BCP are available at the [MPF developer site](#).)

Here’s a diagram that shows what each piece does:



Why are the MPF game engine and media controller two separate processes? Two reasons:

First, having two processes means that each one can run on a separate core in a multi-core host computer. This makes efficient use of hardware since the trend is to have multiple cores. If the game engine and media controller were combined, then your quad-core Raspberry Pi 3 would have all the MPF stuff running on one core while the other three cores were wasted doing nothing.

Second, having two processes means you can replace MPF’s default media controller with something else if you want different features. For example, there is a group of people building an open source [Unity 3D-based media controller](#) which can be used for very advanced 3D display graphics.

The MPF Media Controller

The MPF media controller (which we call “MPF-MC”) is the default media controller option that 99% of MPF users use. (If you haven’t read about what a media controller is and how it fits into MPF, [do that first](#)).

Like MPF, the MPF-MC is also written in Python, using a Python-based multimedia framework called [Kivy](#). Kivy is a wrapper for the native graphics & sound libraries on your computer, and it leverages the latest technologies including SDL2, Gstreamer, and OpenGL.

All of the tutorials and installation guides included in this documentation explain how to install and use the MPF-MC, so there’s really nothing to know about it other than it’s probably the one you’re using.

The MPF Unity BCP Server

The MPF Unity BCP Server is a Unity 3D-based media controller for MPF. You can use it if you want to program your machine’s graphics and sounds via Unity 3D. (If you haven’t read about what a media controller is and how it fits into MPF, [do that first](#)).

MPF’s Unity BCP Server is also free & open source, and hosted in the [unity-bcp-server repo](#) in the Mission Pinball GitHub account. See the readme in that repo for more details including instructions on how to use it.

How to run MPF and the MPF-MC on different computers

Since the BCP protocol uses a standard TCP socket connection, you can actually run MPF and the MPF-MC on different computers. (We’re not sure what the use case for this is exactly, but it’s definitely possible.)

To do it, just install MPF on one computer and MPF-MC on another.

Then on the machine running MPF, configure the `host:` setting as the name or IP address of the machine running the MPF-MC, and on the MPF-MC computer, set the `servers:` section to listen on the IP address you want to use. (See the [bcp section of the config file reference](#) for details.

Remember to set the firewall on the computer running MPF-MC to accept incoming connections on the port that BCP is listening on.

Warning: The BCP protocol has no security, so it’s fine if both the computers are inside your pinball machine or on your home network, but it’s not designed to be run across a public network.

Multiple Simultaneous Media Controller Connections

TODO

`mpf/tests/machine_files/bcp/config/multiple_connections_config.yaml`

Creating your own Media Controller

It's possible to create your own media controller for your own specific needs. All you have to do is listen for incoming BCP connections and then parse the commands and from there you can do pretty much anything you want.

CHAPTER 10

Displays, DMDs, & Graphics

Every electronic pinball machine has some type of display, whether it's 1980s-style 7-segment numeric displays, an early '90s-style alphanumeric display, a mono dot matrix display (DMD), a full color "RGB" DMD, or a modern LCD (which itself can either be a small LCD, like a "color DMD", or a huge one like what Jersey Jack has in the backbox of The Wizard of Oz and The Hobbit).

The MPF media controller is designed so that it can support all types of these displays, including multiple different types of displays at the same time. It supports text, drawing shapes, images, and videos. You can position any combination of these on the display at any time, and you can set layering and transparencies. You can use standard TrueType fonts. You can also apply animations, motions, and transitions to your displays and their widgets. And, like just everything else in MPF, you can do most of your display configuration via the config files.

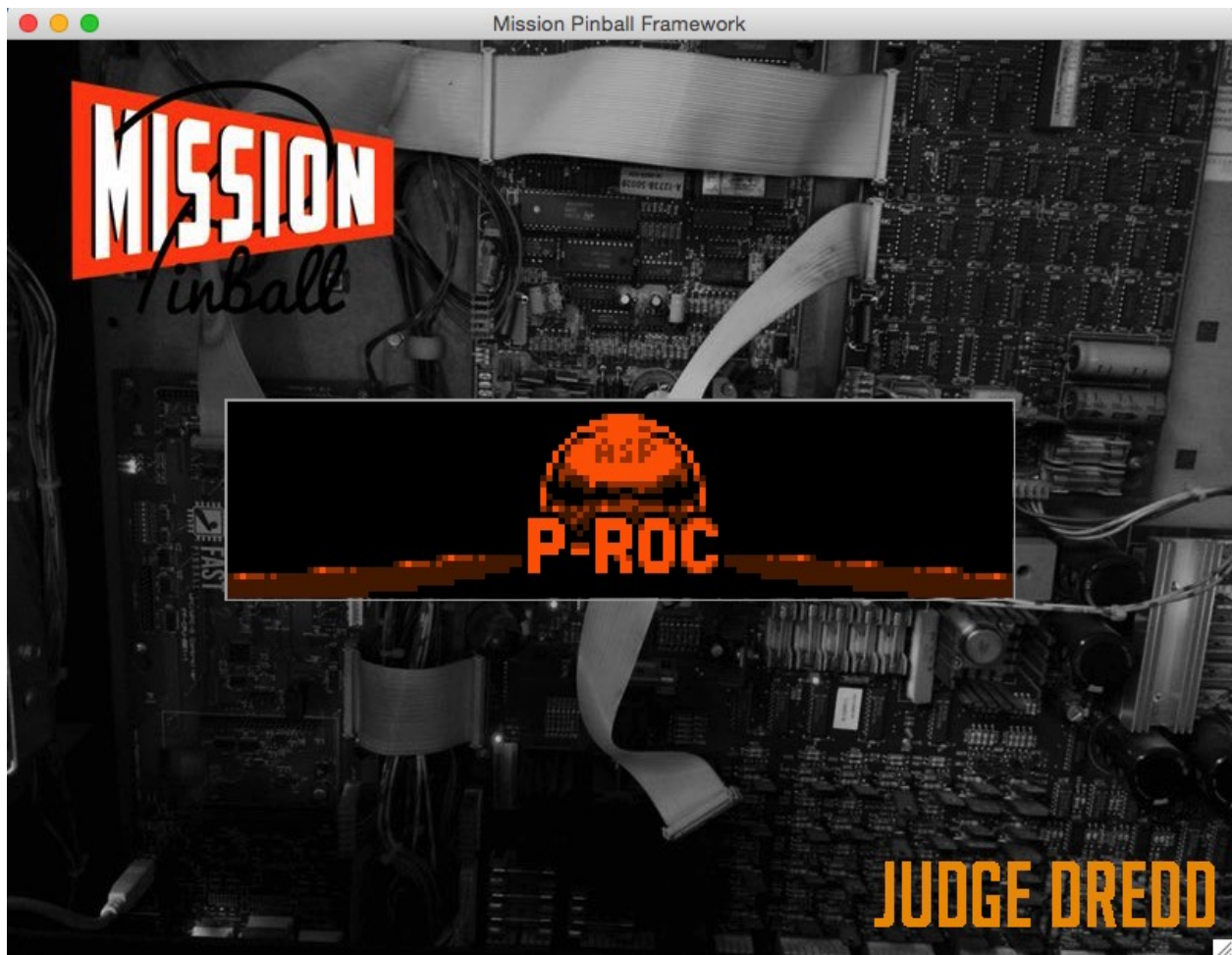
Note: Everything in this "Displays & Graphics" section is about default the MPF Media Controller

Here are a few photos of the MPF Media Controller's display system in action. These were all created with configuration files and without manual programming.

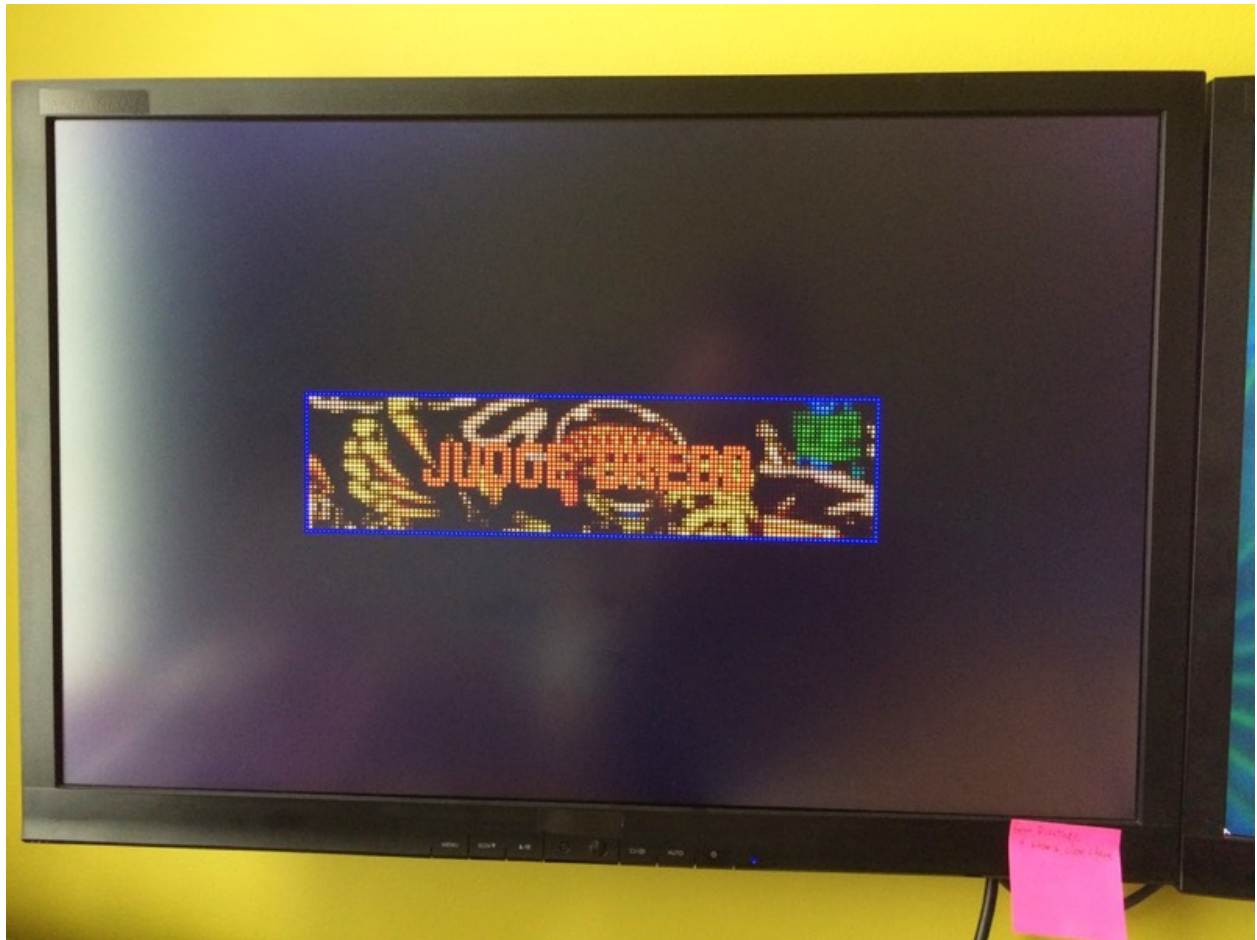
Here's a traditional single-color / mono DMD:



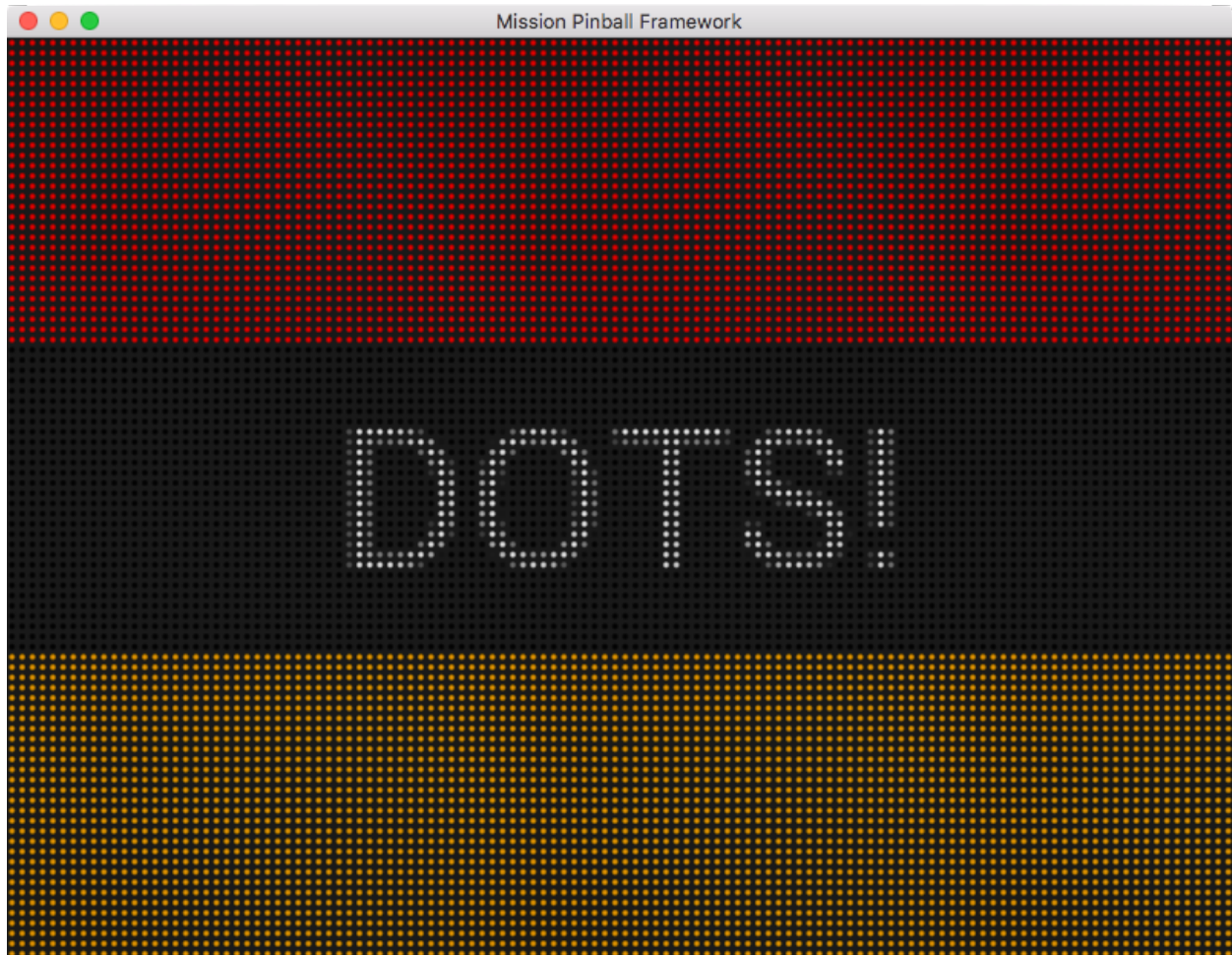
Here's an on-screen window (or what many people called an "LCD" display. In this case, it's showing on single color DMD virtually with no "dot" filter applied, along with other on-screen content:



Here's a "color" DMD on an LCD monitor. It's showing a 128x32 window of color content, with a "dot look" filter to make it look like dots.



Here's a full-size window with the dot filter applied:



Here's a full-color RGB DMD LED matrix. (So it's like a color DMD, but a matrix of 2.5mm RGB LEDs rather than an LCD):



Before we go into the details of all the various display components, let's start with an overview of how the MPF display architecture works. (If you don't care about the details and just want to start using your display, you can jump directly into our [step-by-step tutorial](#) which covers how to get your display running.)

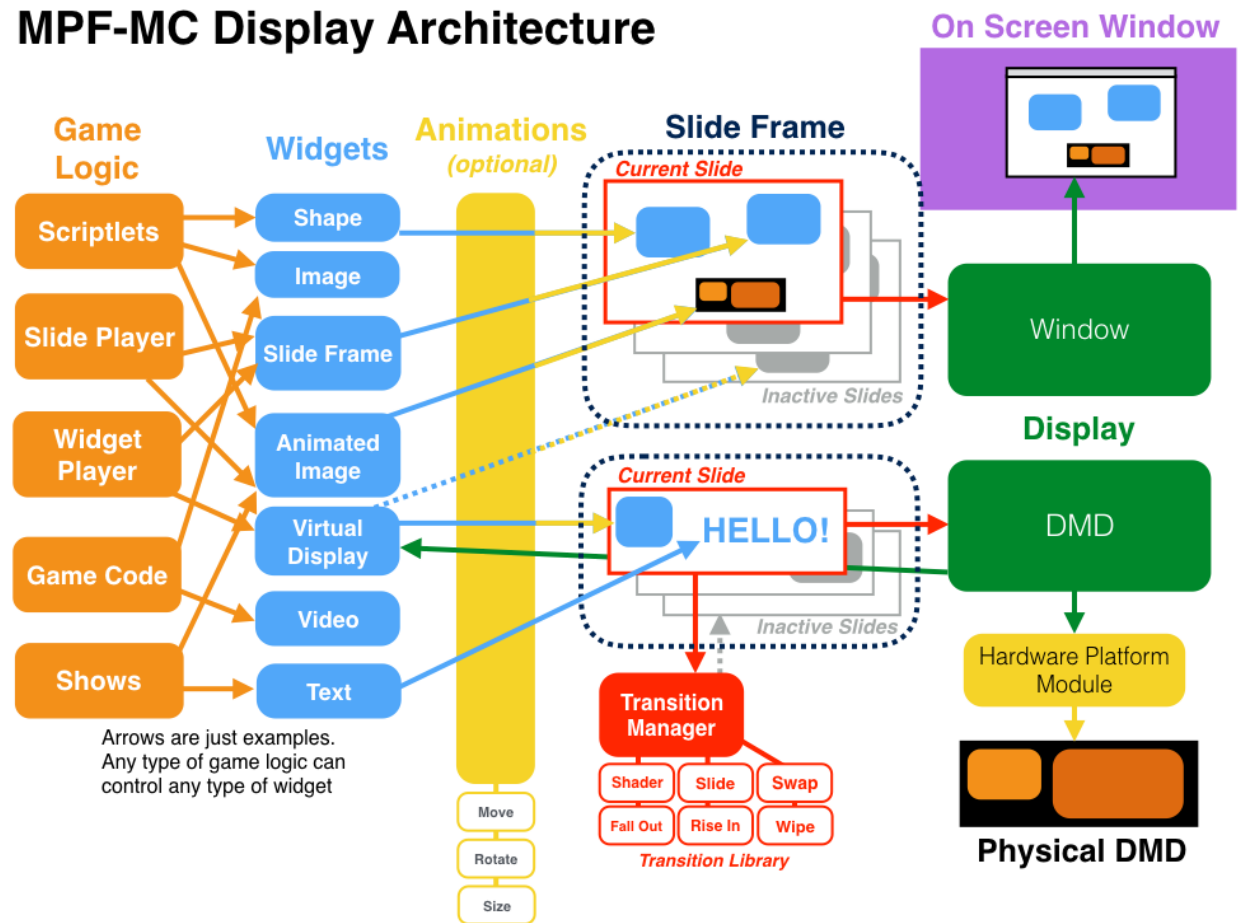
Display Concepts & Architecture

The MPF Media Controller uses the same core architecture to power all kinds of displays, regardless of whether it's a DMD (physical or virtual, monochrome or color), an LCD (on screen window displays), or a combination of both.

The MPF Media Controller's display system is based on Kivy (a multimedia programming library) and uses technologies like SDL2 and Gstreamer under the hood.

Here's an architecture diagram which details how the MPF Media Controller's display system works. It's kind of complex to look at, but we'll step through it piece-by-piece. The good news is that you don't have to understand all of it to use MPF. (You can follow our step-by-step tutorial to get your display up and running just with a few config file entries.) But as you start to create more advanced display effects, it will be helpful to understand how everything fits together.

MPF-MC Display Architecture



The major components of the MPF Media Controller's display system are:

Displays

Every "target" display is setup in MPF as a display. For example, if you have a DMD, that is your display. If you have an LCD with a graphical window, then that is your display. MPF can support multiple displays at the same time, so you could have a DMD in the backbox and then a smaller LCD display on the playfield.

You can even create sub-displays where one display has a small window which is another display (kind of like picture-in-picture). For example, you could use this to have a dot-effect window inside of a high def window on an LCD in the backbox.

Slides

Every display has a list of “slides”, (which are the same height and width of the display). One slide is “active” at a time, meaning it’s the slide that’s showing. Think of these like slides in a slide projector. You’ll probably end up with hundreds of slides, but only one is showing at a time.

You can use transition effects to switch from one slide to another. (These are things like sliding in, pushing, fading, flipping, etc.)

You’ll probably end up with hundreds of slides.

Widgets

Widgets are the “things” you actually put on slides. There are lots of different types of widgets, including text, images, videos, shapes, etc.

Different widgets have different properties, like their x,y position on the slide, their size, color, etc.

You can position widgets on slides with pixel-level accuracy, or you can use relative positions like “10% down from the top edge”, or “centered”, or “25% to the left of center”, etc. Using relative positions means that your display will be resolution independent.

You can also animate the properties of a widget. For example, a widget could start out at the bottom of the display and then move to the center, or you can animate the size, or the color, or the opacity, or pretty much anything else you want. You can chain together multiple animations to run back-to-back, or you can configure multiple animations to happen at the same time.

You can even configure the “curve” of the formula that’s used to animate widgets, so you can have them smoothly accelerate and decelerate, or slow down as they’re animating, or pop into place, etc.

All these concepts come from PowerPoint. :)

The original creators of MPF have day jobs that require them to spend a lot of time with PowerPoint! If you’ve ever used PowerPoint, you should notice that we used PowerPoint (or Keynote or whatever presentation software you like) as the conceptual model for MPF’s display system. In PowerPoint, your content is a series of “slides.” Each slide contains one or more “elements (widgets)”. Those elements can be text, images, videos, drawing shapes, etc. Each element has a “size” (length & width), a “position” on the slide (x,y coordinates), a “layer” which controls how it overlaps with other elements, alpha transparencies, and animation effects (blink, sparkle, move, etc).

And even though your entire PowerPoint presentation is made of lots of slides, only one slide is active on your “display” at a time. Then when you change to another slide, you can have nice animated “transitions” from one slide to the next.

So if the MPF display system seems kind of complex, just think of it like a giant PowerPoint presentation and it should all hopefully make sense. Now let’s start digging into some of the details of each of the parts of the display system.

Working with Displays

The first step to setting up a display in MPF is to use the `displays:` section of your machine-wide config to create a list of displays.

Note that the Tutorial includes a walk-through of setting up your first display. So if you just want to get it up and running quickly, check out the [tutorial](#) instead and then come back here for the nitty-gritty details later.

Here's a very simple example that creates a display called "window" with a height and width of 800x600:

```
displays:
  window:
    width: 800
    height: 600
```

You can name your display whatever you want. For example, here's a display called "potato" which is 100x100:

```
displays:
  potato:
    width: 100
    height: 100
```

You can add multiple displays to your config. Here's an example with a display called "lcd" which is 1366x768, and a second display called "playfield" which is 640x480:

```
displays:
  lcd:
    width: 1366
    height: 768
    default: true
  playfield:
    width: 640
    height: 480
```

The "lcd" display above also has a setting `default: true`. As you can imagine, when you have more than one display, then when you are setting up content to be shown on the display, you have to specify which display you want it to show up on. Picking one display to be your default is the display that's used for content where you don't explicitly set which display you're using.

Note: Full details and options for these displays are available in the [displays: section](#) of the config file reference.

These "displays" are logical, not physical!

One concept that's somewhat confusing for new users is that the displays you set up here are not yet tied to physical displays in your pinball machine. You can think of these as "logical" displays which you can use in your config files and game code. But when it comes to using a physical display, you have to "link" the physical display hardware to one of these logical displays.

One final note about the displays you specify in your `displays:` section: The size (height and width) of your displays here are independent from the actual physical displays (windows and DMDs). For example, the size of the on-screen window is specified in the `window:` section of the machine config (which is 800x600 by default). So if you change the size of your display here (perhaps to 320x240), then the on-screen window will still be 800x600, and the content of the display canvas will be 320x240 (but scaled up to the 800x600 window). This means that MPF is “resolution independent”, in that you can build your game for a certain display size and then scale it up or down to fit on whatever physical display is there later.

Let’s walk through some examples of how you can actually configure various displays. You don’t have to read through all of these—just pick whichever display type you want to use in your machine.

Using an LCD for a display

This guide will show you how to use an on-screen LCD window for your main display. This would be like what Jersey Jack does in Wizard of Oz or The Hobbit.

Here’s what the final version of the relevant sections of your machine config file will look like. We’ll step through everything one-by-one.

```
displays:
  window:
    height: 800
    width: 600

window:
  width: 800
  height: 600
  title: Mission Pinball Framework
  resizable: true
  fullscreen: false
  borderless: false
  exit_on_escape: true
  source_display: window
```

1. Add your display

The first part of the config file is where you create your display called “window” and set its size:

```
displays:
  window:
    height: 800
    width: 600
```

This is just like we covered in the *Working with Displays* section.

2. Add your window configuration

Next you need to add a section to your machine config file which has the settings for the actual on-screen popup window. This is configured in the `window:` section.

Most of the settings here are pretty self-explanatory. The most important thing is the `source_display:` window section which is where you specify which display (from the `displays:` section of your config) will provide the actual source content for your on-screen window.

(That said, if you only have one display, or if you have a display called “window”, then the on-screen window will automatically use that display for its source, but we’re just including it here for completeness.)

The other important thing to point out is that you have to specify the size of your display and your window separately. In the example above, we have an 800x600 window showing the content from an 800x600 display. But we could, for example, set the display to 400x300 while keeping the window at 800x600. In that case, the display content would be “scaled up” to fit the window, meaning that each source pixel would be 2x2. This would be how you’d do a low-res old-school look on a modern high-def window.

You can play with the other settings to see how they affect things. The full list of window options is in the [window:](#) section of the config file reference. (Just be sure that you add them to the `window:` section of your config, not the “window” entry in the `displays:` section.) Check that out to see what else you can do.

Note: At this time, the MPF Media Controller only supports a single LCD window at a time. If you want more than one LCD window, MPF 0.31 will let you run multiple instances of the MPF-MC at the same time—one for each window.

Now you have a working config, so you can read through the rest of the display documentation to see how you can add slides and widgets to your display.

Also, if you want to make the content on your window look like dots, or if you want to show a “virtual” DMD in your window, check out the other guides in this section.

Using a traditional (single color) physical DMD

This guide will show you how to use a traditional, physical DMD with MPF, like this:

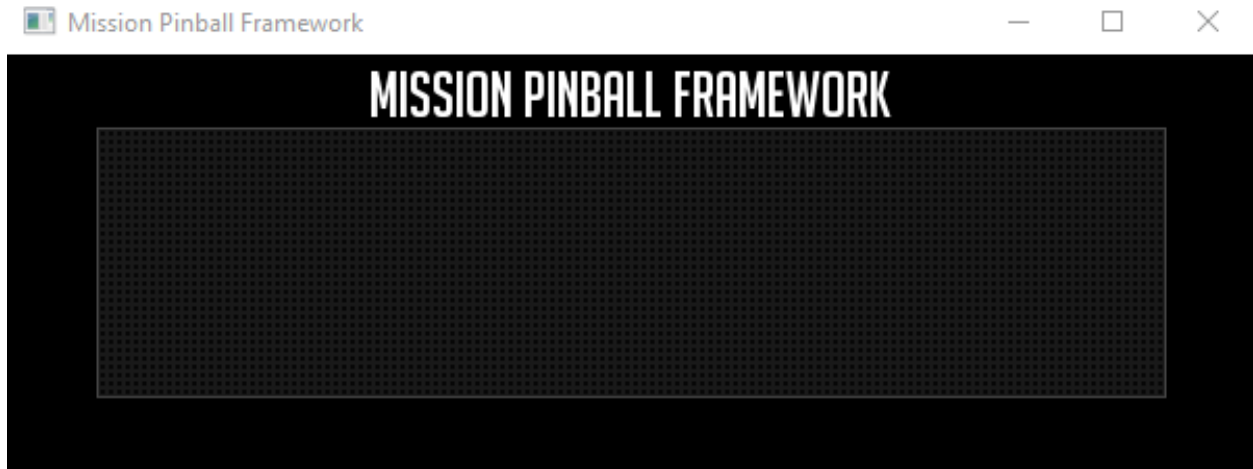


This is supported with the following control systems:

- *FAST Pinball Core & WPC controllers*

- *P-ROC*

It will also show you how to create an on-screen popup window which will show the contents of the DMD, like this (with a blank DMD):



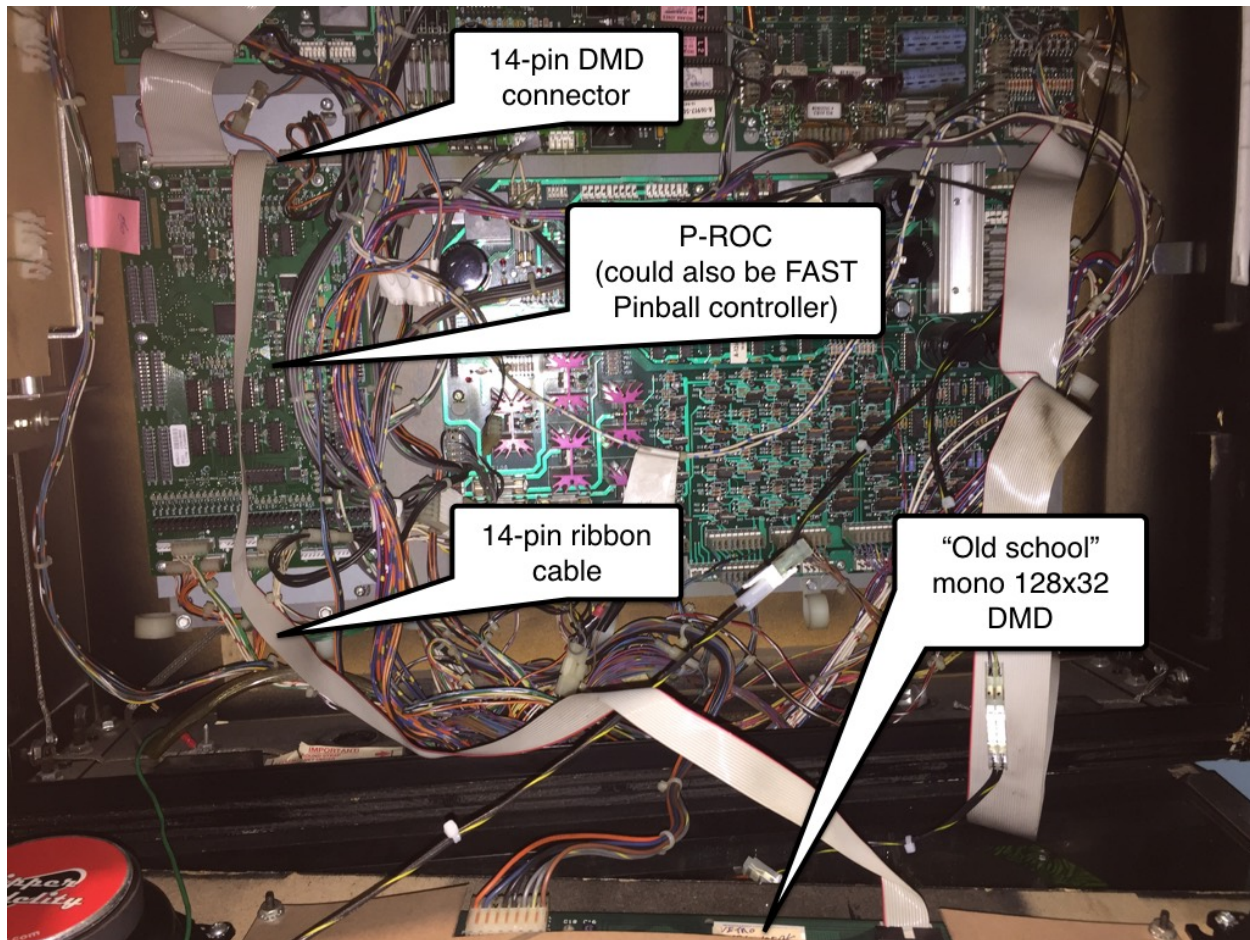
If you want to use a physical DMD without the on-screen equivalent, we'll show you how to do that at the end.

If you want to only have an on-screen DMD without the physical one, like if you want to replace the DMD with an LCD screen but still have it look like a DMD, then read [this guide](#) instead.

The final version of the relevant sections of your machine config for a physical DMD with an on screen window too will look like this:

1. Understand how physical, mono DMDs work

This guide explains how to config physical single-color (mono) DMDs. These are DMDs that are connected to your FAST Pinball or P-ROC controller via the 14-pin ribbon cable, like this:



It makes no difference whether you're using an LED or an original plasma gas DMD. (Also it doesn't matter what color it is.)

2. Add your displays to your MPF config

The first part of the config file above is where you create your logical displays like we covered in the [Working with Displays](#) section.

```
displays:
  window:
    width: 600
    height: 200
  dmd:
    width: 128
    height: 32
    default: true
```

We're creating two displays here. The first is called "window" and has a size of 600x200. This will be the display that shows up on the computer screen.

The second display, which we're calling "dmd", will be the display that provides the content for the physical DMD. This display is 128x32, which is the pixel size of the DMD.

Notice that we set `default: true` for the dmd display. This is because as we're creating display

content in our game, we want it (by default) to show up in the DMD (since that will be the primary display in our game).

Note that you don't set colors or anything here—this is just setting up the logical displays which we'll use next.

3. Add your window configuration

Next, we have a `window:` section which holds the settings for the actual on screen window itself. In this case we're just configuring it to be 800x600, with a window title of "Mission Pinball Framework".

```
window:
  width: 600
  height: 200
  title: Mission Pinball Framework
```

Check out [Step 2. of the LCD guide](#) for more details on this window section, and be sure to check out all the window options in the `window:` section of the config file reference.

Notice that in this case, we did not add the `source_display:` window setting to this section. That's because we have a logical display called "window", and when you have that, the on-screen window will automatically use that display as its source.

4. Configure a window slide to show the on screen DMD

Now we have a working on-screen window and a working physical RGB DMD. But if you run `mpf` both now, your on screen window will be blank because we haven't built any slides to show up.

So in this step, we're going to build a slide for the on-screen window that will be shown when MPF starts. We'll add some widgets to that slide to make it look like the screen shot at the beginning of this guide.

First, create a `slides:` section in your machine config (if you don't have one already), and then create an entry for the slide that we want to show. In this case, we've decided to name that slide "window_slide_1". (Of course you can call this slide whatever you want.)

```
slides:
  window_slide_1:
```

Next we have to add some widgets to that slide. (Refer to the [documentation on widgets](#) if you're not familiar with widgets yet.)

The first widget will be a [DMD widget](#) which is a widget which renders a logical display onto a slide in a way that makes it look like a DMD:

```
- type: dmd
  width: 512
  height: 128
  pixel_color: ff5500
```

Again, there are lots of options here. Note that we're adding a `height:` and `width:` of 512x128. This is the on-screen pixel size of the DMD as it will be drawn in the window. In this case we chose an even multiple of the source display for the DMD (which is 128x32), meaning that each pixel of the original DMD will be rendered on screen as 4 pixels by 4 pixels. This is big enough to get the circular "dot

look” filter to look good, and being an even multiple means that we won’t have any weird moire patterns.

For the on screen DMD, we are able to select the pixel color, because this is how the DMD will be drawn on the computer screen, and MPF has no idea what color the actual DMD is. So you can pick any color you want here. We chose `ff5500` which is a classic DMD orange color.

There are other options listed in the [DMD widget](#) documentation to control settings like how big the circles are versus the space in between them, the ability to not have the “dot” filter, and the ability to set the “glow” radius of each dot, color tint, limiting the color palette, etc.

Note that in this case, we did not have to add the `source_display:` option because we have a display called “dmd” which will automatically be used as the source for the color DMD widget.

Next, we also added two more widgets to this slide—a text widget with the title of the machine, and a gray rectangle that’s slightly larger than the DMD to give it a nice border.

```
- type: text
  text: MISSION PINBALL FRAMEWORK
  anchor_y: top
  y: top-3
  font_size: 30
- type: rectangle
  width: 514
  height: 130
```

5. Configure the slide to show when MPF starts

Now we have a nice slide with the virtual DMD on it, but if you run MPF, you still won’t see it because we didn’t tell MPF to show that slide in the window. So that’s what we’re doing here:

```
slide_player:
  init_done:
    window_slide_1:
      target: window
```

If you don’t have a `slide_player:` entry in your machine-wide config, go ahead and add it now. Then create an entry for the [init_done](#) event. This is the event that the media controller posts when it’s ready to be used, so it’s a good event for our use case.

Then under that event, create an entry to show the slide you just created in the previous step. Notice that we also have to add the `target: window` entry to tell the slide player that we want this slide to show on the “window” target. We need to do this because the default display (from Step 2) is the DMD, so if we don’t specify a target, this slide will show on the default, which would be the DMD, instead of being shown on the window. (In this case, we would show a slide on the DMD which contains a DMD widget whose source is the DMD, and we’d probably open up some kind of wormhole and destroy the universe. So don’t do that.)

And this point, you’re all set! Of course there’s no content on the DMD yet because we haven’t set up any `slide_player` entries to add content to it, but that’s something you can do by following the tutorial or looking at the guides for the slides and widgets here.

6. What if you don't want the on-screen window?

There might be some scenarios where you just want the physical DMD with no on-screen DMD. (For example, maybe you're using a low-power single board computer and you don't have enough horsepower to run a graphical environment.)

This is fine. To do it, just remove the window-related components from the config.

In this case, you wouldn't need the `default: true` entry for the `dmd` in the `displays:` section because you only have one display, so it will automatically be the default.

7. Configure the physical DMD

At this point you have two displays configured, and you have default content showing up in both of them. The final step is to add the configuration for your physical DMD so that MPF can talk to your hardware.

The exact steps to do that vary depending on which DMD hardware platform you've chosen, so click on the one you have from the list below and follow the final instructions there to get everything set up.

- [FAST Pinball Core & WPC controllers](#)
- [P-ROC](#)

Using an RGB full-color LED DMD

Related Config File Sections
displays:

MPF supports RGB full-color LED DMDs. There are several hardware options you can use for this:

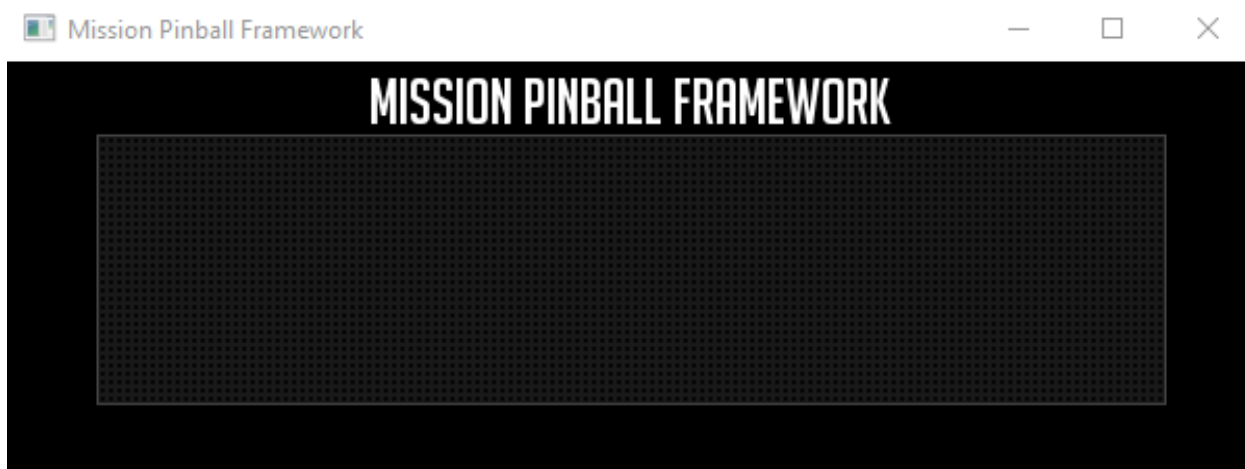
- [SmartMatrix](#)
- [RGB.DMD](#)
- [FAST Pinball RGB DMD](#)

This guide shows you how to configure MPF to use one of these displays.

By the way, these RGB LED DMDs have been called “real” Color DMDs in the forums since the displays are arrays of RGB LEDs rather than an LCD monitor running a display that is made to look like a DMD. Many people like these better than LCD-based displays because they're brighter and more vibrant, and the blacks are actually black since the LEDs are off versus LCD displays which have blacks that are actually dark gray.



We will also show you how to create an on-screen popup window which will show the contents of the DMD, like this (with a blank DMD):



If you want to use a physical RGB DMD without the on-screen equivalent, we'll show you how to do that at the end of this guide.

If you want to only have an on-screen DMD without the physical one, like if you want to replace the DMD with an LCD screen but still have it look like a color DMD, then read [this guide](#) instead.

The final version of the relevant sections of your machine config for a physical RGB DMD with an on screen window too will look like this:

1. Shout-out to Eli Curtz!

It's likely that no one would be using RGB LED DMDs if it wasn't for the efforts of Eli Curtz.

Eli first posted about these types of panels in the P-ROC forum in 2014. At that time we could only find panels with 3mm spacing between pixels which was a bit larger than traditional pinball DMDs, but that's what kicked off the conversation about, "Whoa, maybe we could use these for 'real' color DMDs some day." Then in September 2015, Eli posted again telling us that we could now get panels with 2.5mm spacing which is the perfect size we need. Eli also showed us how to connect them and what software we needed to make everything work. So really everything here is because of Eli. All we did is take everything he showed us and write it down. (Well, that and we also created the interface for MPF, but that was the easy part.) So thanks Eli!

2. Add your displays to your MPF config

Next, add the DMD display to your list of displays in your machine-wide config file:

```
displays:
  window:
    width: 600
    height: 200
  dmd:
    width: 128
    height: 32
    default: true
```

The example above contains two displays. The first is named “window” and has a size of 600x200. This will be the display that shows up on the computer screen. (Again, if you just want the DMD without an on-screen window, we’ll show you how to do that later, but for now it’s probably easiest to create a screen window so you can see what’s happening with the display if you’re working on your game without a physical machine attached.)

The second display, which we’re calling “dmd”, will be the display that provides the content for the physical RGB DMD. This display is 128x32, which is the pixel size of the DMD. If you have a different size DMD, enter the size (in pixels) here.

Notice that we set `default: true` for the DMD display. This is because as we’re creating display content in our game, we want it (by default) to show up in the DMD (since that will be the primary display in our game).

3. Add your window configuration

The `window:` section of the machine-wide config holds the settings for the on-screen display window. If you don’t have this section, add it now.

You can make the width and height anything you want. In this case we’re just configuring it to be 600x200 with a window title of “Mission Pinball Framework”.

```
window:
  width: 600
  height: 200
  title: Mission Pinball Framework
```

Check out [Step 2. of the LCD guide](#) for more details on this window section, and be sure to check out all the window options in the [window:](#) section of the config file reference.

Notice that in this case, we did not add the `source_display: window` setting to this section. That’s because we have a logical display called “window”, and when you have that, the on-screen window will automatically use that display as its source.

4. Configure a window slide to show the on screen DMD

Now we have a working on-screen window and a working physical RGB DMD. But if you run `mpf` both now, your on screen window will be blank because we haven’t built any slides to show up.

So in this step, we’re going to build a slide for the on-screen window that will be shown when MPF starts. We’ll add some widgets to that slide to make it look like the screen shot at the beginning of this guide.

First, create a `slides:` section in your machine config (if you don't have one already), and then create an entry for the slide that we want to show. In this case, we've decided to name that slide `"window_slide_1"`. (Of course you can call this slide whatever you want.)

```
slides:  
  window_slide_1:
```

Next we have to add some widgets to that slide. (Refer to the [documentation on widgets](#) if you're not familiar with widgets yet.)

The first widget will be a [Color DMD widget](#) which is a widget which renders a logical display onto a slide in a way that makes it look like a DMD:

```
- type: color_dmd  
  width: 512  
  height: 128
```

Again, there are lots of options here. Note that we're adding a `height:` and `width:` of 512x128. This is the on-screen pixel size of the DMD as it will be drawn in the window. In this case we chose an even multiple of the source display for the DMD (which is 128x32), meaning that each pixel of the original DMD will be rendered on screen as 4 pixels by 4 pixels. This is big enough to get the circular "dot look" filter to look good, and being an even multiple means that we won't have any weird moire patterns.

There are other options listed in the [Color DMD widget](#) documentation to control settings like how big the circles are versus the space in between them, the ability to not have the "dot" filter, and the ability to set the "glow" radius of each dot, color tint, limiting the color palette, etc.

Note that in this case, we did not have to add the `source_display:` option because we have a display called `"dmd"` which will automatically be used as the source for the color DMD widget.

Next, we also added two more widgets to this slide—a text widget with the title of the machine, and a gray rectangle that's slightly larger than the DMD to give it a nice border.

```
- type: text  
  text: MISSION PINBALL FRAMEWORK  
  anchor_y: top  
  y: top-3  
  font_size: 30  
  color: white  
- type: rectangle  
  width: 514  
  height: 130  
  color: 444444
```

5. Configure the slide to show when MPF starts

Now we have a nice slide with the virtual DMD on it, but if you run MPF, you still won't see it because we didn't tell MPF to show that slide in the window. So that's what we're doing here:

```
slide_player:  
  init_done:  
    window_slide_1:  
      target: window
```


If you don't have a `slide_player:` entry in your machine-wide config, go ahead and add it now. Then create an entry for the `init_done` event. This is the event that the media controller posts when it's ready to be used, so it's a good event for our use case.

Then under that event, create an entry to show the slide you just created in the previous step. Notice that we also have to add the `target: window` entry to tell the slide player that we want this slide to show on the "window" target. We need to do this because the default display (from Step 2) is the DMD, so if we don't specify a target, this slide will show on the default, which would be the DMD, instead of being shown on the window. (In this case, we would show a slide on the DMD which contains a DMD widget whose source is the DMD, and we'd probably open up some kind of wormhole and destroy the universe. So don't do that.)

And this point, you're all set! Of course there's no content on the DMD yet because we haven't set up any `slide_player` entries to add content to it, but that's something you can do by following the tutorial or looking at the guides for the slides and widgets here.

6. What if you don't want the on-screen window?

There might be some scenarios where you just want the physical DMD with no on-screen DMD. (For example, maybe you're using a low-power single board computer and you don't have enough horsepower to run a graphical environment.)

This is fine. To do it, just remove the window-related components from the config.

In this case, you wouldn't need the `default: true` entry for the `dmd` in the `displays:` section because you only have one display, so it will automatically be the default.

7. Configure your RGB DMD Hardware

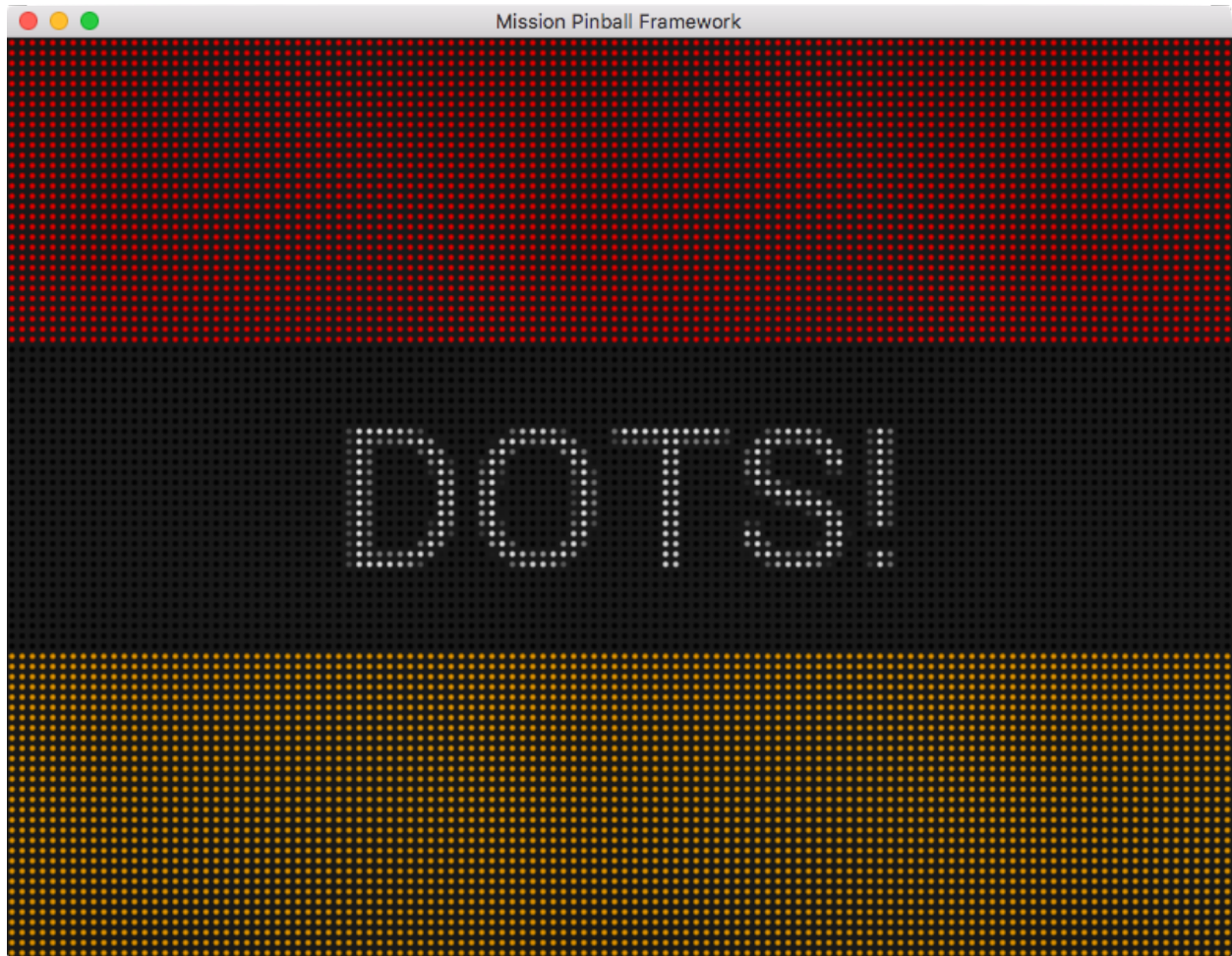
At this point you have two displays configured, and you have default content showing up in both of them. The final step is to add the configuration for your physical RGB DMD so that MPF can talk to your hardware.

The exact steps to do that vary depending on which DMD hardware platform you've chosen, so click on the one you have from the list below and follow the final instructions there to get everything set up.

- [*SmartMatrix*](#)
- [*RGB.DMD*](#)
- [*FAST Pinball RGB DMD*](#)

How to give your on-screen window the DMD "dot look"

This guide will show you how to configure a full screen "dot look" display, like this:



The final sections of the machine config to make this happen are here:

```
displays:
  window:
    width: 800
    height: 600
  dmd:
    width: 120
    height: 90
    default: yes

slides:
  window_slide:
    - type: color_dmd
      width: 800
      height: 600
      pixel_size: .5

  dmd_slide:
    - type: text
      text: DOTS!
    - type: rectangle
      width: 120
      height: 30
```



```
    color: orange
    y: 0
    anchor_y: bottom
- type: rectangle
  width: 120
  height: 30
  color: red
  y: top
  anchor_y: top

slide_player:
  init_done:
    window_slide:
      target: window
    dmd_slide:
      target: dmd
```

Let's step through this step-by-step.

1. Create your displays

To understand how this works, you have to understand the concepts of MPF *displays* and *widgets*.

What's actually happening under the hood is that you set up two MPF displays. The first is the "window", which is the display that represents your on-screen window. This should be set to the size of the screen window at the native resolution of the monitor or LCD where it's being shown.

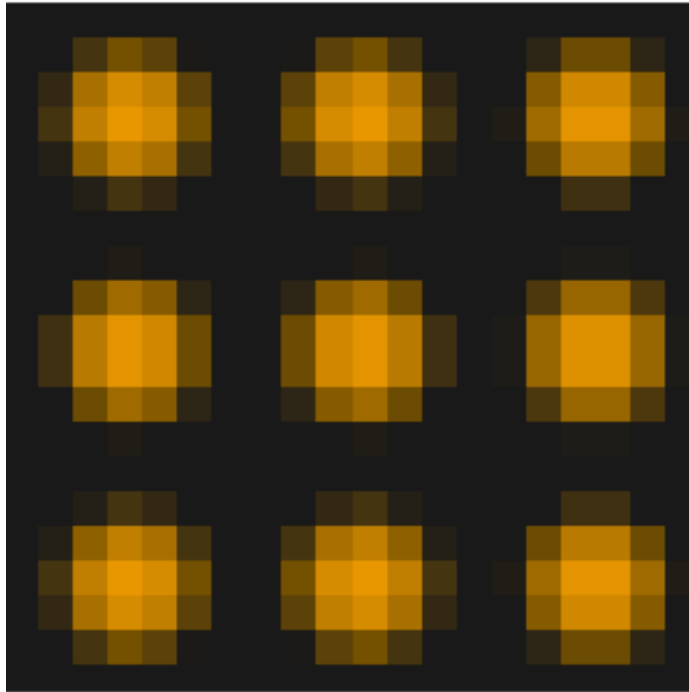
```
displays:
  window:
    width: 800
    height: 600
  dmd:
    width: 120
    height: 90
    default: yes
```

In the example above, this is 800x600, but on your actual machine, it will probably be something like 1024x768, 1280x1024, 1600x1200, etc.

The second MPF display represents the virtual DMD itself, and you set that to the number of pixels (or dots) you want to be drawn in your window. In the example above, this is set to 120x90, meaning the virtual DMD is 120 dots wide and 90 dots tall. You can make this anything you want.

The key to remember is that the parent window will be using its pixels to draw the individual dots that make up the virtual DMD. So a smaller DMD resolution means the window has more pixels to use per-dot, resulting in a better overall image.

For example, if we zoom in on the 120x90 virtual DMD being shown on an 800x600 window, we'll see that it looks like this:



This works because there is about a 6x6 grid of pixels in the window for each virtual pixel in the DMD.

But if you increased the virtual DMD to 400x300 (instead of 120x90), that would mean you only had a 2x2 window area to render each pixel, and it wouldn't really work because you can't draw a circle with space around it in a 2x2 pixel.

Also note that we added `default: yes` to the `dmd display`, since as we get deeper into the machine config, we want all the content (the `slide_player`, etc.) to show up in the DMD display.

2. Create your window slide

Once you have your displays configured, the next step is to create the slide that will be shown in the window. In this case, the slide will only have a single widget, and that widget will be the `Color DMD` widget which will be used to render the virtual DMD into the window.

```
slides:
  window_slide:
    - type: color_dmd
      width: 800
      height: 600
      pixel_size: .5
```

We decided to name this slide “`window_slide`”, though you can name it whatever you want.

Note that in this case, we set the width and height of the `color_dmd` widget so that it's the same size as the window itself. This is what causes it to be scaled to the full size of the window.

We do *not* set the number of dots in the DMD here, as that's automatically pulled in from the `dmd display` setting.

We also do not need to set a source display for the `color_dmd` widget since it will automatically use a display called “`dmd`”.

3. Create your DMD slide

Next, we need a slide to show in the DMD itself. This is just something we're setting up here as an example "first slide". In your actual game, this slide will be ever changing and will reflect what's happening in your machine.

We're calling our first slide "dmd_slide":

```
dmd_slide:
- type: text
  text: DOTS!
- type: rectangle
  width: 120
  height: 30
  color: orange
  y: 0
  anchor_y: bottom
- type: rectangle
  width: 120
  height: 30
  color: red
  y: top
  anchor_y: top
```

There's nothing special about this slide. We just added a text widget and two colored rectangles.

4. Configure your slides to show up

Finally, we need to create a `slide_player` entry which will cause the two slides we just created to be shown. In this example, we're using the [init_done event](#) since that's the event that's posted by the media controller once it's been initialized and ready to go.

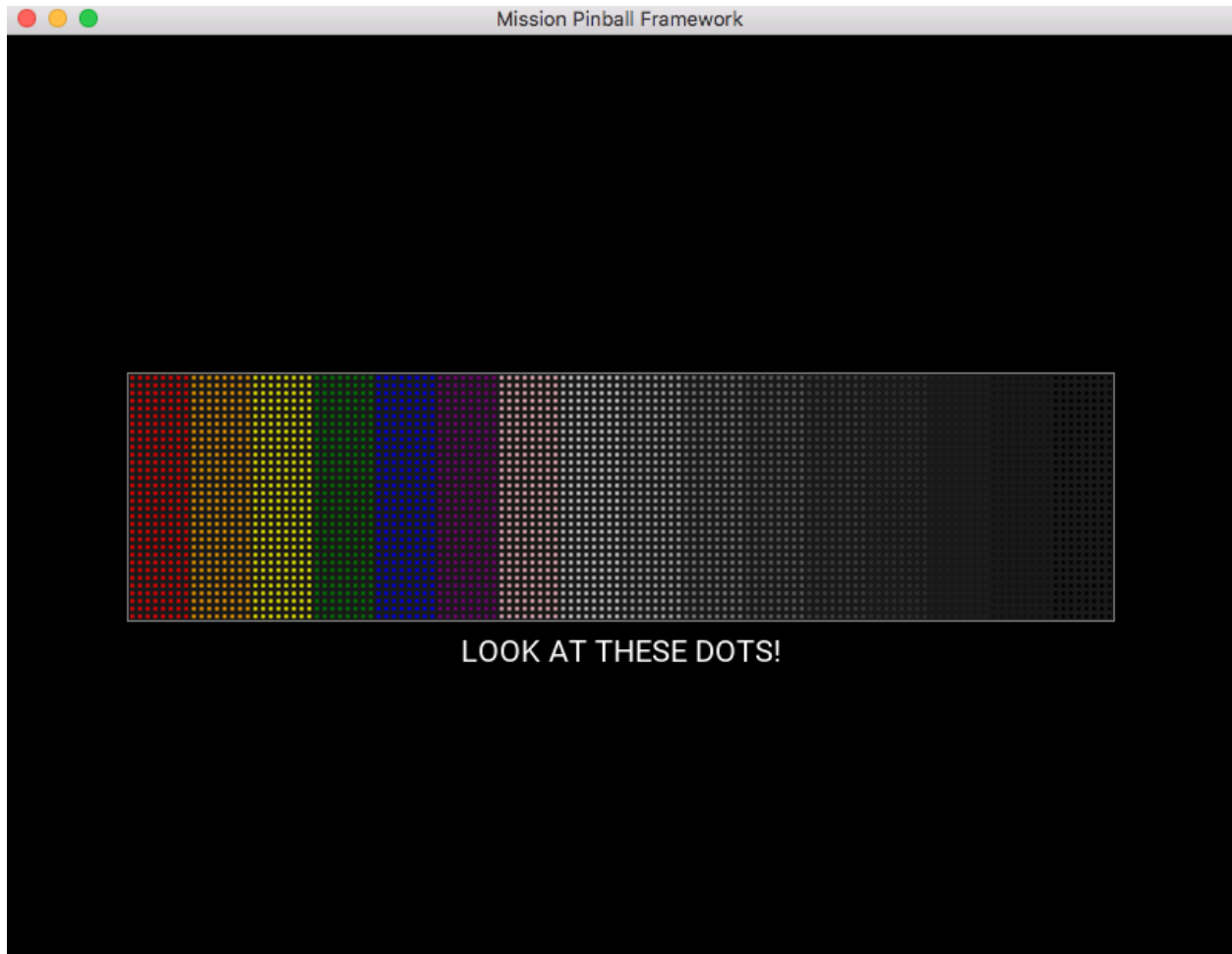
```
slide_player:
  init_done:
    window_slide:
      target: window
    dmd_slide:
      target: dmd
```

Since the DMD display is configured to be the default, when you use the `slide_player` in the rest of your game, you won't have to specify `target: dmd`. We just included it here to make it clear that we were targeting the window slide to the window display and the dmd slide to the dmd display.

5. Other options & positioning your DMD

Finally, remember to check the documentation for the [color_dmd widget](#) for a full list of the options you can use to fine-tune how the DMD looks in the window. For example, you can configure the pixel size, the glow radius, the color of the space between the pixels, gain, tint, etc.

Also, you don't have to make the virtual DMD be the full size of the display. For example, if you set your dmd display to be 128x32 and then set the `color_dmd` widget to be 640x160, you'll get a display like this:



You can also use the [widget sizing and positioning](#) to create a DMD widget that is pre-positioned at a certain spot on the display. This is useful if you have a standard size LCD monitor in your backbox but only part of it is visible to the player. In that case you could make a `color_dmd` widget that was the size of the viewable area and use the widget positioning settings to align it to the area of the display that was visible.

You can also use the various [window:](#) options (such as full screen) to properly align the content of the display with the visible area.

Finally, even though this example was using the `color_dmd` widget, you could replace it with the [dmd widget](#) for a single color look instead of full color.

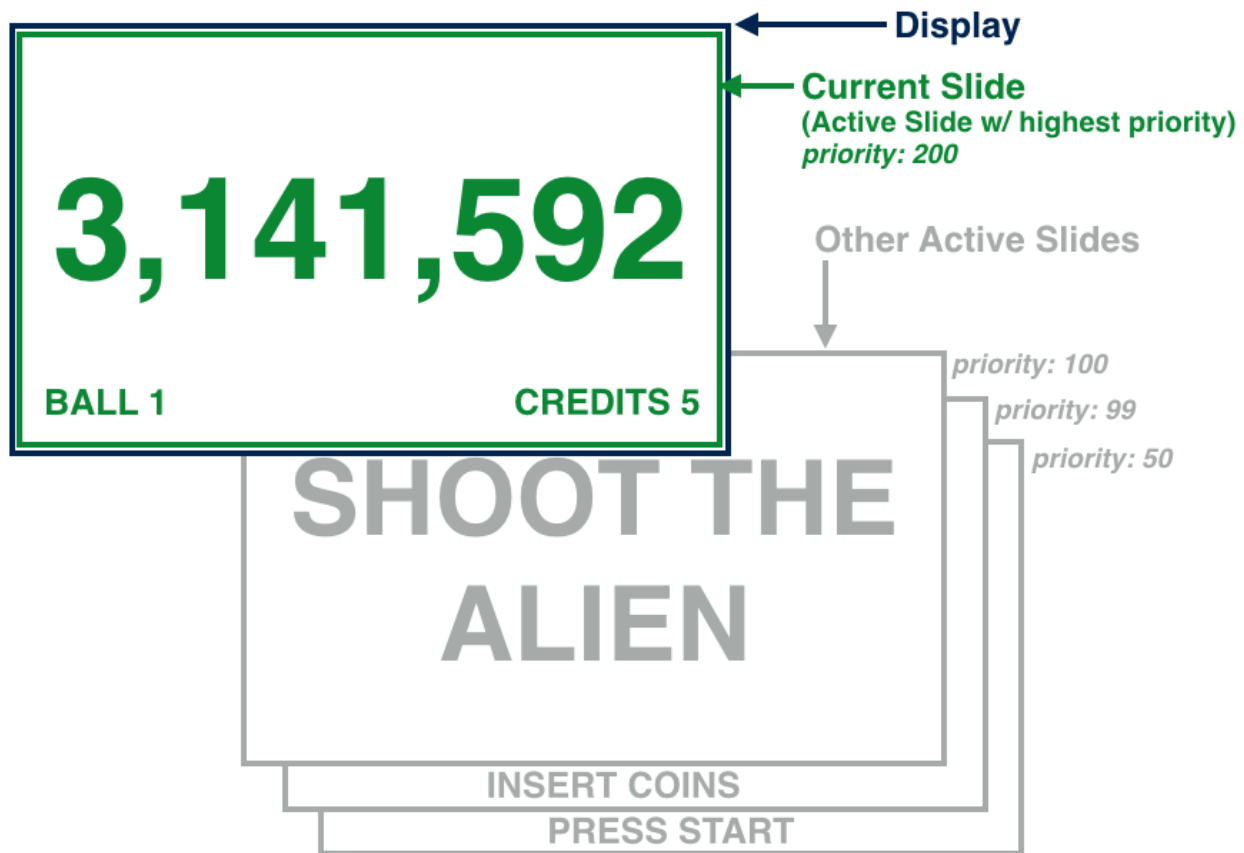
Alpha-Numeric / Segment Displays

MPF does not yet support segmented displays but we plan to soon. This document is just included here so you know we're working on it! :) We'll support both alphanumeric and classic 7-segment numeric-only displays.

Slides

Now that you know what a display is, the next concept you need to understand is “slides”. Slides in MPF are just like slides in a PowerPoint presentation or slides in an old-fashioned slide projector.

You create multiple slides (each with its own content), and then you tell MPF when to activate certain slides. Every slide has a priority, so if multiple slides are active at the same time, the one with the highest priority will be shown. You can also set “transitions” which control what visual effect is used to transition from the current slide to the new slide. (Transitions are things like cross-fade, move in, push out, etc.)



Slide Priorities

Every slide in MPF has a priority, which is simply a numeric value. Bigger numbers equal higher priority.

Since only one slide is shown at a time, whenever there is more than one active slide, whichever slide has the highest priority will be the one that’s shown.

For example, you might have a general score slide at priority 100 which shows the current player’s score, the ball, the credits, and maybe the scores of the other players.

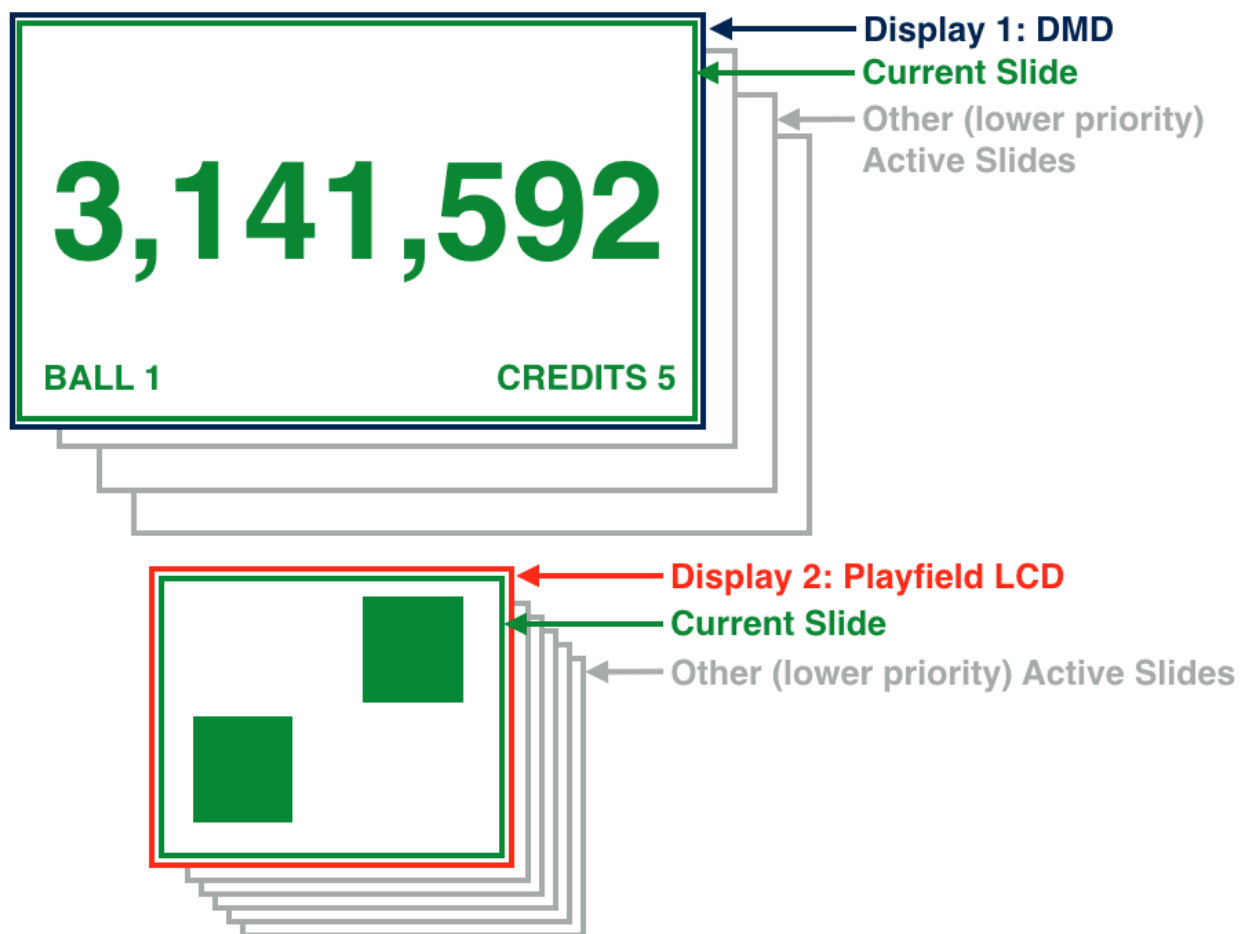
If the player shakes the machine too hard and a tilt warning slide is shown, then that tilt warning slide might be activated at a priority of 10,000, meaning that it would be shown instead of the general score slide.

Then after a few seconds, the tilt warning slide might be removed, and MPF will then show the next-highest active slide which would most likely be the general scoring slide that was showing before.

The slide priority system is integrated into MPF's mode system, meaning that slides created by modes automatically inherit the priority of the mode that's showing them. Put another way, a slide from a higher priority mode would show in place of a slide from a lower priority mode (though every mode doesn't need to have slides). You can also tweak the priorities of slides (higher or lower) to make sure the slide you want to show is the one that's showing at any given time. We'll dig into that later in the documentation.

Slides with Multiple Displays

When MPF is used with *multiple displays*, each display maintains its own stack of active slides. The priorities of the slides in the stack and the priority of the current slide on one display has nothing to do with the active and current slides of another display.



How to create slides

Since slides are so critical in MPF's display system, let's look at how you actually create slides.

There are several ways you can define and create slides:

- In a *slides*: section of a config file.
- Dynamically in the *slide_player*: section of your config.
- Dynamically in a show config or show file.

Let's look at each of these options.

Defining slides in the *slides*: section of a config file

The main way to do it is in the “slides” section of a config file, like this:

```
slides:
  some_slide:
    - type: text
      text: THIS IS MY SLIDE
  some_other_slide:
    - type: text
      text: THIS IS ANOTHER SLIDE
    - type: text
      text: WITH MORE WORDS
      y: bottom
      anchor_y: bottom
  tilt_warning_1:
    - type: text
      text: WARNING
  tilt_warning_2:
    - type: text
      text: WARNING WARNING
```

In the example above, we have four main sub-entries in the slides section:

- *some_slide*
- *some_other_slide*
- *tilt_warning_1*
- *tilt_warning_2*

Each of the above listed subsections represents a different slide, and the names of those sections are used as the names of those slides. In other words, this config has a slide called “*some_slide*”, another slide called “*some_other_slide*”, etc.

You can list slides in a *slides*: section of either your machine-wide or a mode config. The most important thing to know about slide names is that they are GLOBAL throughout MPF. That means that MPF has a single master list of all the slide names used in the entire game. (So don't use the same slide name twice or it will get confused.)

The configuration entries under each slide name are the widgets that will be added to that slide. (Each slide can have one or more widgets. You can read about all the different types of widgets, as well as the options for widget positioning and sizing, in the *widgets* section of the documentation.

You'll probably end up creating hundreds of slides in your machine by the time you're done with it.

Note: The slides defined in the *slides*: section are just the configurations that are used to create the slides when they're needed. In other words, no memory is used to “hold” the slides, so you can create

lots and lots of them without worrying about running out of memory.

At this point, you're just creating the slides. Deciding when to show which slide will come later.

Since MPF maintains a single global list of slides, it doesn't technically matter whether you define your slides in the [slides:](#) section of your machine-wide config or your mode config. Obviously though if you define the slides a mode will use in that mode's config file, then that will help you keep everything more organized.

Dynamically defining slides in a `slide_player:` section of a config file

The [slide_player:](#) section of a machine-wide or mode config is where you tell MPF to show (or "play") a specific slide when some event occurs. Full documentation for the `slide_player` is in the [How to Show a Slide on a Display](#) section of the documentation.

You can define slides in the `slide_player` like this:

```
slide_player:
  some_event:
    my_slide_1:
      - type: text
        text: THIS IS MY SLIDE
```

In the above example, when the event `some_event` is posted, the slide player will respond and show the slide called `my_slide_1` which will include that single text widget.

It doesn't really matter whether you pre-define a slide in the [slides:](#) section of a config versions dynamically defining it in the [slide_player:](#) section. Really it comes down to personal preference. Some people like to have all their slides in one location (all in the [slides:](#) section), whereas others prefer to have the configuration for the slides closer to where they will be used (by defining them in the [slide_player:](#) section). Most people end up mixing-and-matching, with some quick-and-dirty one-time use slides in the `slide_player` with other slides you might reuse in the `slides:` section.

Dynamically defining slides in a show config

As you'll learn in other parts of this documentation, anything that's in one of the `"_player"` sections of the config (like the `"slide_player"` above), can also be defined in a show configuration (from a show file or a show configuration section of a config file).

So here's an example of a slide created within a show for use within a specific step in that show:

```
# show_version=4
- time: 0
slides:
  my_show_slide_1:
    - type: text
      text: MISSION PINBALL
      color: red
    - type: rectangle
      width: 128
      height: 32
```


Again, see the [show documentation](#) for details. Here we’re just showing that it’s also possible to define a slide in a show config.

How to Show a Slide on a Display

Once you have your [slides created](#), you need to decide which slides you show when.

Using the `slide_player`

The most common option is to use the [slide_player](#) section of a config file. This can be in either your machine-wide or in mode-specific config files. (Like all mode settings, slides in a mode-based config file will only play when that mode is active.)

The slide player is based on MPF’s [events system](#), meaning that you basically say, “play THIS slide when THAT event happens”.

For example, if you want to play a slide named “good_job” when the event “left_lane_hit” is posted, you would set your config like this:

```
slide_player:
  left_lane_hit: good_job
```

You can have as many event/slide combinations as you want, like this:

```
slide_player:
  left_lane_hit: good_job
  right_lane_hit: good_job
  left_ramp_hit: ramp_champ
```

The above examples are what we call the “express” config option since each event specifies a slide name, but no other options. (It just uses the default options for showing each slide. But instead of putting the slide name after the event name, you can also create a sub-entry with the slide name, then *another* sub-entry with additional options, like this:

```
slide_player:
  right_ramp_hit:
    ramp_hit_slide:
      expire: 2s
      target: dmd
```

You can mix-and-match all of these in a single config, like this:

```
slide_player:
  left_lane_hit: good_job
  right_lane_hit: good_job
  left_ramp_hit: ramp_champ
  slide_player:
    right_ramp_hit:
      ramp_hit_slide:
        expire: 2s
        target: dmd
```

In the example above, when the event “left_ramp_hit” happens, the slide “ramp_champ” is shown. When the event “right_ramp_hit” happens, the slide “ramp_hit_slide” is shown, but with the additional

options of setting the slide to expire (to be removed) after 2 seconds, and for that slide to show on the “dmd” display target instead of the default display.

There are many options for the `slide_player` in addition to the “expire” and “target” options shown above. Refer to the [slide_player](#): section of the config file reference for full details.

Adding slides to a show

The `slide_player` is one of MPF’s many [Config Players](#) (so called because they use a “config” section to “play” things). Config players can be used in a config file (as shown above) and also in a show step. To use the slide player in a show, you add a [slides](#): section to a show step.

For example, if you want a slide called “happy_face” to play in a step in a show, you can do it like this (this is a snippet of a single step in a show):

```
- duration: 3s
  slide: happy_face
```

Again, you can use the sub-entry format to specify additional options:

```
- duration: 3s
  slide:
    happy_face:
      target: playfield_screen
```

Creating new slides in the slide_player

Both of the options we’ve show so far (using the [slide_player](#): section of a config file and using the [slides](#): section of a show) have used existing named slides that you would have already defined in the [slides](#): section of a config. You also have the option to define new slides directly in each of these sections. See the [How to create slides](#) section of the documentation for instructions on how to do that.

Slide Transitions

When MPF switches the current slide on a display with another slide, you can set a transition effect that controls what this slide transition looks like. You can use these transitions with the `slide_player` and within shows. You can set transitions as a property of the new slide that comes in, or as a property of the outgoing transition when the current slide is removed. You can also control the duration (speed) of the transition.

Here’s a list of all the types of transitions that MPF supports. Note that if you’re reading the PDF or Epub version of this documentation, if you visit the documentation website (docs.missionpinball.org) then this page contains animated GIFs which show each of these transitions in action.

none

Setting a transition type of none means that no transition will be used, and the incoming slide instantly replaces the current slide.

push

The push transition means that the incoming slide “pushes” the outgoing slide out of the way. (e.g. the outgoing slide moves out while the incoming slide moves in)

Options for the push transition:

- duration: MPF *time string* Default is 1 second.
- easing: See the *easing instructions* for details.
- direction: left, right, up or down.

move_in

The move in transition means that the incoming slide moves in on top of the outgoing slide. The outgoing slide is not animated.

Options for the move_in transition:

- duration: MPF *time string* Default is 1 second.
- easing: See the *easing instructions* for details.
- direction: left, right, top or bottom.

move_out

Not working yet.

wipe

The wipe transition means that the display is wiped from the outgoing slide to the incoming one. Neither slide is animated.

Options for the wipe transition:

- duration: MPF *time string* Default is 1 second.

swap

The swap transition simulates an app screen swap like on a mobile device. The outgoing slide moves out of the way and the incoming slide comes in on top of it.

Options for the swap transition:

- duration: MPF *time string* Default is 1 second.

fade

The fade transition is a classic crossfade from the outgoing slide to the incoming one.

Options for the fade transition:

- duration: MPF *time string* Default is 1 second.

fade_back

The fade_back transition causes the outgoing slide to shrink and fade away, revealing the incoming slide.

Options for the fade_back transition:

- duration: MPF *time string* Default is 1 second.

rise_in

The rise in transition causes the incoming slide to fade in and rise up from the center of the display. It's essentially the opposite of the fade_back transition.

Options for the rise_in transition:

- duration: MPF *time string* Default is 1 second.

Configuring Transitions

Transitions are specified as an additional property of a `slide_player:` `config` or the `slides:` section of a show config. For example:

```
slide_player:
  left_ramp_hit:
    slide1:
      transition:
        type: push
        duration: 2s
        direction: right
```

Hopefully the above example is obvious by now. When the event “left_ramp_hit” happens, MPF will show the slide called “slide1”, using the push transition, with a transition time of 2 seconds, pushing the new slide in from the right.

Transitions can be combined with other slide settings, like this:

```
slide_player:
  left_ramp_hit:
    slide1:
      transition:
```



```

    type: push
    duration: 2s
    direction: right
    target: dmd

```

You can also configure `transition_out`: settings which are transitions that will be applied to a slide when it is removed, like this:

```

slide_player:
  left_ramp_hit:
    slide1:
      transition:
        type: push
        duration: 2s
        direction: right
      transition_out:
        type: fade_away

```

Note: If the current slide has a `transition_out`: setting, and the new slide has a `transition`: setting, then the new slide's transition setting will take precedence.

How to configure a multiplayer display

TODO

How to do “picture in picture” display

TODO

How to configure a “split screen” display

TODO

Display Targets

todo

Slides Events

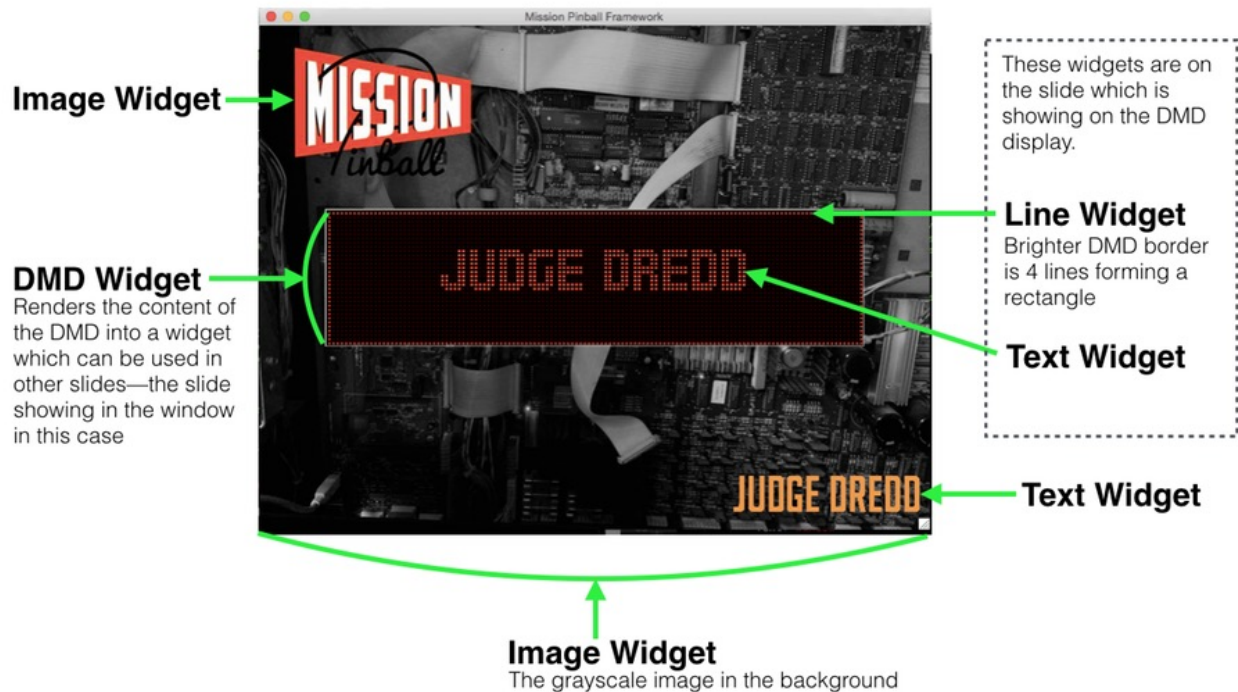
These events can be useful within players. For example, if you want to play 3 slides as a mode begins then the `mode_(name)_started` event can trigger the `slide_1` - but what triggers `slide_2` and `slide_3`?

The `slide_player`: can be used to sequence the playing of additional slides using the `slide_slide_1_removed` event to trigger the next slide to be played.

Related Events
<code>slide_(name)_active</code>
<code>slide_(name)_removed</code>

Widgets

If a slide is a blank canvas, then “widgets” are the things you put on that blank canvas, like text, images, shapes, videos, etc. Here’s an example of a slide (on the window display) showing how it’s made up of different types of widgets.



Widgets have properties like size and position, and some widgets include additional properties depending on what type of widget they are. (Text widget have font properties, video widgets have properties controlling video playback, etc.)

You can control the stacking order of widgets on a slide (also called the “layer” or “z-order”), to specify which widget should be on top of another if they’re overlapping.

You can specify all the widgets that are on a slide when you define that slide, and/or you can add widgets later to existing slides or remove certain widgets from slides while keeping others there.

You can even create a library of reusable “named” widgets which you can use again and again on many slides.

You can specify widget “styles” which are default properties that are inherited by all widgets based on that style. (So, for example, you could specify a set of styles for text widgets called “title”, “default” and “small” that control the font name, font size, color, and spacing for widgets using that style.

Individual widget properties can also be animated, meaning you can change the size, position, opacity, etc. of a widget over time. You can animate multiple properties of a widget at the same time or in a sequence (or both), and you can specify which MPF events trigger animation sequences to start and stop.

In this section of the documentation, we’ll look at all the different types of widgets (and their properties and settings), then look at how you position and animate them, how to use widget styles, and how you can create the reusable widgets.

Types of Widgets

Most popular

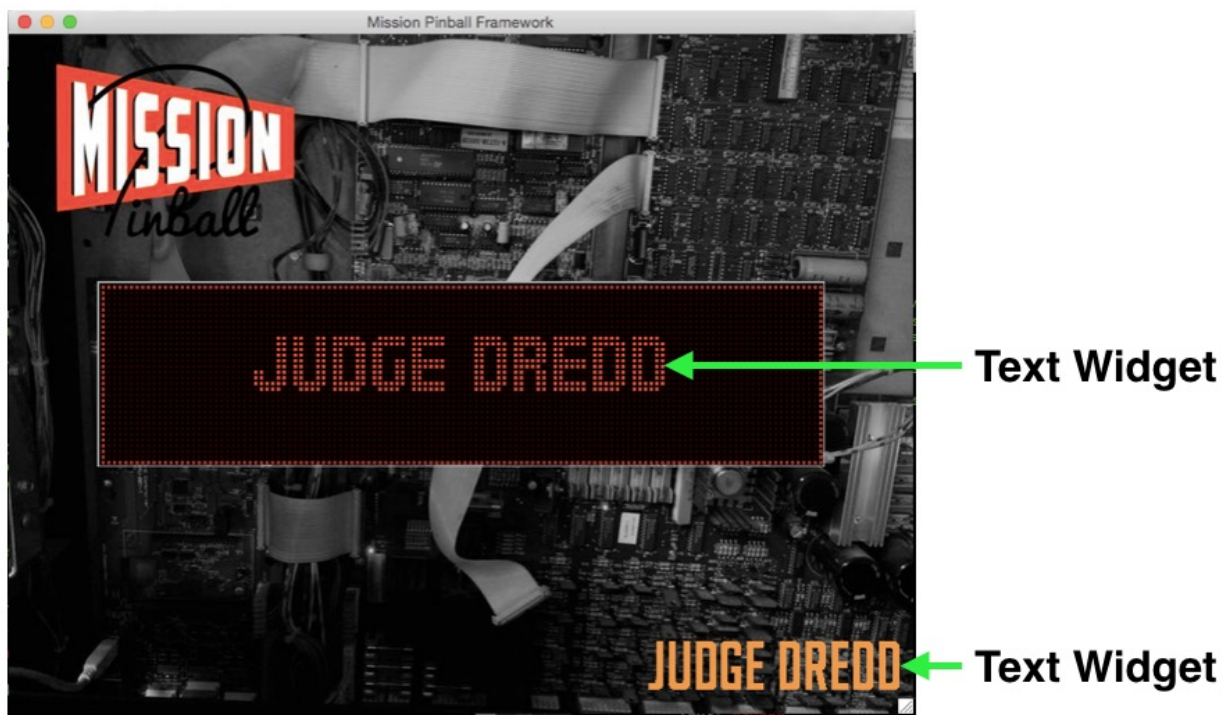
- Text
- Image
- Video

But also these:

- Bezier Curve
- Color DMD
- DMD
- Ellipse
- Line
- Points
- Quad
- Rectangle
- Slide Frame
- Text Input
- Triangle
- Common Settings (all widgets)

Text Widget

The text widget is used to show text on a *slide*.



In addition to being able to specify static text, text widgets also include powerful functionality:

- You can configure dynamic text that is automatically updated (in real time) based on the value of a player variable or a machine variable.
- You can configure a placeholder “text string” that uses a lookup value to get its actual text. This is useful for things like multi-language support, or to be able to have different text strings based on a configuration file (family-friendly versus R-rated text, etc.)
- You can configure fonts and font styles to be automatically applied to text, and you can override them on a widget-by-widget basis.

Settings

Here are a list of the settings you can use for text widgets:

```
type: text
text:
font_size:
font_name:
bold:
italic:
number_grouping:
min_digits:
halign:
valign:
```

Note: Text widgets also have “common” widget settings for position, opacity, animations, color, style,

etc. Those are not listed here, but are instead covered in [common widget settings](#) page.

Also remember that all widget settings can be controlled via [widget styles](#), rather than you having to set every setting on every widget.

type: text

Tells MPF that this is a text widget. This setting is required when using text widgets.

text:

This value is required. If you don't want text, use ""

Your text can contain placeholders as described in [dynamic text](#).

font_name:

The name of the font you want to use. This is the name only, without the file extension. For example:

Correct:

```
font_name: arial
```

Wrong:

```
font_name: arial.ttf
```

There's a lot that goes into fonts, so we have a whole section on [fonts](#) which you should read.

Usually fonts are controlled via [widget styles](#). Also, if you're using a DMD or color DMD (or other pixel-style display), we have some [built in DMD fonts](#) that you can use which are pre-configured for DMDs.

font_size:

The size of the font (in points). Default is 15.

See the [full documentation on fonts](#) for details.

bold:

Boolean (True/False or Yes/No) which controls whether this font is bold. Note that this setting attempts to over-draw the font a few times to make it look bold, so the results are often not that great. You're better off finding an actual bold version of your font and using that font instead.

The default setting is False.

italic:

Boolean (True/False or Yes/No) which controls whether this font is italicized. Note that this setting simply skews the font when it's drawn, so the results are often not that great. You're better off finding an actual italicized version of your font and using it instead.

The default setting is False.

number_grouping:

Boolean (True/False or Yes/No) which controls whether you want the separator between digits. In other words, it converts 1234567 into 1,234,567.)

Note that this setting will search through the text string for digits and then insert the commas. In other words, if your text is "YOU SCORED 12345 POINTS", then it will convert it into "YOU SCORED 12,345 POINTS" even though the text is a mix-and-match of letters and numbers.

The default setting is False. (Note that prior to MPF 0.30, the default setting was True.)

Todo: Currently this setting only inserts a comma. We need to add a setting to allow other characters (like a period which is common in Europe). If this is you, post a message to the forum and we'll bump up the priority on our to-do list.

min_digits:

Configures the minimum number of digits for the text to be displayed. This setting adds zeros to the left for digits that are shorter than the setting.

This is typically used in score displays, since pinball machines usually show a score as 00 instead of 0 when the player starts the game and has no points.

So for most machines, you'd add min_digits: 2 to your text widgets which show the player's score.

The default setting is 0.

halign:

Specifies the horizontal alignment of the text within the bounding box. Note that this setting *is not used* to align a widget on the screen. (See the [How to position widgets on slides](#) documentation for details on that.)

This setting is almost never used in MPF because the bounding box of a text widget is automatically created and sized based on the actual text and font chosen.

The default setting is center.

valign:

Specifies the vertical alignment of the text within the bounding box. Note that this setting *is not used* to align a widget on the screen. (See the [How to position widgets on slides](#) documentation for details on that.)

This setting is almost never used in MPF because the bounding box of a text widget is automatically created and sized based on the actual text and font chosen.

The default setting is middle.

anchor_y: baseline

Text widgets have an additional baseline option in addition to the other baseline options detailed in the *common widget settings* documentation.

Examples

The example config files section of the documentation contains *examples of text widgets*.

Dynamically Updating Text

Related Config File Sections
<i>text widgets</i>
<i>segment displays</i>

Your text can contain placeholders which will be replaced and updated when the text is shown. Use (param) to replace the parameters of the event which triggers the text (usually you do not want to use this). Player vars from the current player can be accessed using (player|var) (e.g. (player|score) or (player|ball)). Furthermore, you can target a specific player using (playerX|var) where X is the player number starting at 1 (e.g. (player1|score)). To display machine variables use (machine|var) (e.g. (machine|credit_string)).

Text Substitution Strings

Image Widget

The image widget is used to display an image on a *slide*. It's also used to display animated images, which can either be animated GIFs or a folder or zip file of sequentially-numbered images (of any type).

Image types that support alpha channels (like PNGs) are supported.

Settings

```
type: image
image:
width:
height:
allow_stretch:
keep_ratio:

fps:
```



```
loops:  
auto_play:  
start_frame:
```

Note: Image widgets also have “common” widget settings for position, opacity, animations, color, style, etc. Those are not listed here, but are instead covered in [common widget settings](#) page.

Also remember that all widget settings can be controlled via [widget styles](#), rather than you having to set every setting on every widget.

type: image

Tells MPF that this is an image widget

image:

The name of the image asset this widget will show. Details on image assets are [here](#).

width:

Not yet implemented. TODO

Default is 0

height:

Not yet implemented. TODO

Default is 0

allow_stretch:

Not yet implemented. TODO

Default is False

keep_ratio:

Not yet implemented. TODO

Default is False

fps:

For animated images, sets how fast it plays (frames per second).

Default is 10.

loops:

The number of times an animated image will loop. Set to 0 for unlimited. (Note this is different than other areas of MPF, which use -1 to indicate unlimited loops.)

Default is 0.

auto_play:

If the image is an animated image, configures whether it plays automatically when it's loaded.

Default is True.

This is good for looping images, but if you have an image you want to play at a specific point, you probably want to set this to no and play it from specific events via the widget player.

start_frame:

Not yet implemented. TODO

Default is 0.

Video widget

The video widget is used to display a video on a [slide](#). This can either be full-screen videos or smaller videos that appear on a portion of the display.

Note that in MPF, videos are regular widgets, so they can go on top of other widgets, or other widgets can go on top of them, they can be moved and animated, etc.

Settings

```
type: video
video:
height:
width:
volume:
auto_play:
end_behavior:
control_events:
```

Note: Video widgets also have “common” widget settings for position, opacity, animations, color, style, etc. Those are not listed here, but are instead covered in [common widget settings](#) page.

Also remember that all widget settings can be controlled via [widget styles](#), rather than you having to set every setting on every widget.

type: video

Tells MPF that this is an image widget

video:

The name of the video asset this widget will show. Details on video assets are [here](#).

height:

Allows you to specify the size (along with `width:` of the video on the screen). Set to 0 (or leave this setting out) to play the video at whatever size the asset is configured for (or, if a size is not specified there, at the native video size).

Note that the `height:` and `width:` settings cannot stretch or skew the video. So if you enter values that result in an aspect ratio for the video widget that does not match the video itself, then the video will be sized as large as it can within the bounds of the size of the widget.

width:

Lets you specify the width of the video. Set to 0 (or leave the setting out) to use the setting from the video asset and/or the native video width.

See the `height:` setting above for details.

volume:

Volume for this video on a scale from 0 to 1. Default is 1.0. Note that you can the volume during playback via the `control_events:` below.

Note: Currently the video volume and playback is not integrated with the rest of MPF's sound system in terms of tracks, ducking, etc. This is on our roadmap.

auto_play:

Boolean (True/False or Yes/No) which controls whether this video should start playing automatically. Default is True.

end_behavior:

Sets what happens when the video ends. Options include:

loop The video loops and starts playing again

pause The video stops and stays at the end (so it continues showing the final frame)

stop The video stops and the position is reset back to the beginning. This is the default.

control_events:

Control the playback of this video with MPF events. Options include:

play Starts playing the video from its current position.

pause Pauses the video at its current position.

stop Stops the video and resets the position back to the beginning.

seek Moves the video to a certain position based on a percentage. 0 is the beginning of the video, 1 is the end, 0.5 is 50% through, etc. (This is similar to `position:`, except it's based on percent instead of position.)

This setting does not change the play/stop state.

position Moves the video to a certain position based on the time, (in seconds). In other words value: 4.2 here would move the video to the 4.2 second mark. (This is similar to `seek:` except it's based on seconds instead of percent.)

volume Sets the volume of the video on a scale from 0 to 1.

This setting does not change the play/stop state.

To use control events, add a `control_events:` section to the video widget, then create a list (with dashes) of `event:`, `action:` and (optionally) `value:` settings. Then when the event is posted, the action will be applied to the video.

Consider the example below:

```
slides:
  my_slide:
    - type: video
      video: my_video
      control_events:
        - event: play_my_vid
          action: play
        - event: wizard_caught
          action: stop
        - event: some_event
          action: pause
        - event: what_event
          action: seek
          value: .5
        - event: move_it
          action: position
          value: 4.2
        - event: mute_me
          action: volume
          value: 0
```

In the example above, when the event `play_my_vid` is posted, the video will start playing. When the event `wizard_caught` is posted, the video will stop. `some_event` will pause the video, `what_event` will reset the video to the 50% position, `move_it` will set the video to the 4.2 second position, and `mute_me` will set the volume to zero.

Note that you can have as many different entries as you want here, even using different events for the same actions, etc.

Camera Widget

The camera widget is used to show live video from an attached camera a [slide](#).

Here's an example:

```
#config_version=4

slide_player:
  mc_ready:
    camera_example:
      - type: camera
        width: 800
        height: 600
```

Settings

```
type: camera
width:
height:
camera_index:
```

TODO

Bezier Curve Widget

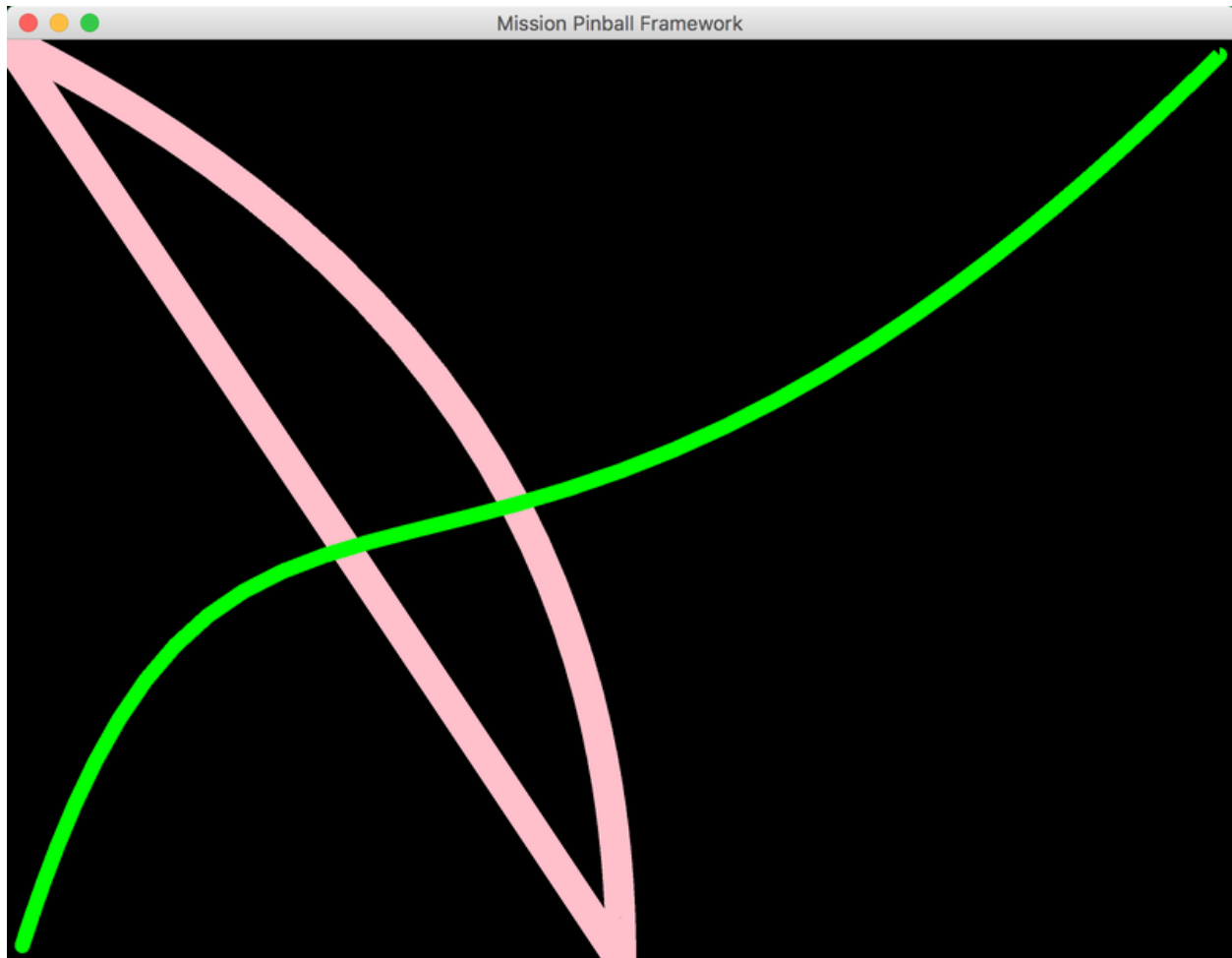
The bezier widget is used to draw a curved line on a [slide](#). (Note that if you want to draw a straight line, you can use the [Line Widget](#).)

Here's an example:

```
#config_version=4

slide_player:
  mc_ready:
    bezier_example:
      - type: bezier
        points: 10, 10, 150, 450, 300, 100, 790, 590
        color: lime
        thickness: 5
        cap: none
      - type: bezier
        points: 0, 600, 400, 400, 400, 0
        color: pink
        close: true
        joint: miter
        thickness: 10
```

Which results in the following:



Settings

```
type: bezier
points:
thickness:
cap:
joint:
cap_precision:
joint_precision:
close:
precision:
```

Note: Bezier widgets also have “common” widget settings for position, opacity, animations, color, style, etc. Those are not listed here, but are instead covered in [common widget settings](#) page.

Also remember that all widget settings can be controlled via [widget styles](#), rather than you having to set every setting on every widget.

type: bezier

Tells MPF that this is a bezier curve widget. This setting is required when using bezier curve widgets.

points:

A list of points which make up the bezier curve, expressed in x/y pairs (so the number of items here has to be even).

The first pair is the starting point. The last pair is the ending point. Each pair in between is a point the curve will pass through.

For example:

```
points: 10, 10, 200, 50, 300, 200
```

This would draw a bezier curve starting at (10,10) and ending at (300,200), with a center point at (200, 50).

thickness:

The thickness of the line. You'll probably have to play with different settings to get it right. The default is 1.0, so 2.0 is twice as thick as the default, 0.5 is half as thick, etc.

cap:

Determine the cap of the line, defaults to 'round'. Can be one of 'none', 'square' or 'round'

joint:

Determine the join of the line, defaults to 'round'. Can be one of 'none', 'round', 'bevel', 'miter'.

cap_precision:

Integer, defaults to 10.

Number of segments for drawing the "round" joint, defaults to 10. The joint_precision must be at least 1.

joint_precision:

Integer, defaults to 10.

Number of segments for drawing the "round" joint, defaults to 10. The joint_precision must be at least 1.

close:

Boolean (True/False), default is False.

If True, the line will be closed.

precision:

Integer, defaults to 180.

The number of individual segments that will be drawn between each pair of points.

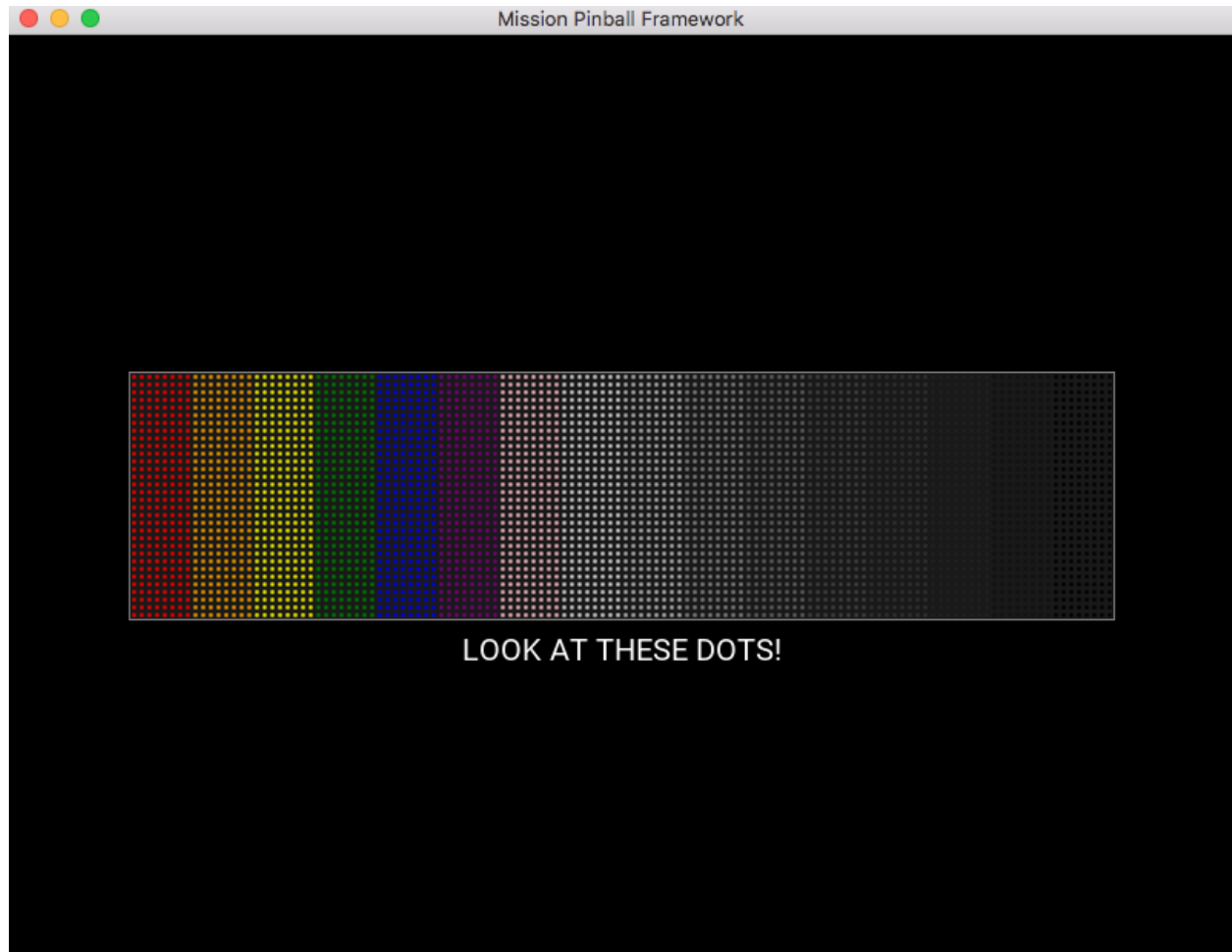
Examples

The example config files section of the documentation contains *examples of bezier widgets*.

Color DMD Widget

The Color DMD widget is used to render a *display* on a *slide* and to apply options that make it look like a DMD (dot filters, etc.).

Here's an example:



This is how you get a “Color DMD” look on your LCD display. (The [How to give your on-screen window the DMD “dot look”](#) guide walks you through that.)

Note that the Color DMD Widget really is unrelated to whether you have a [physical RGB DMD](#) in your machine. (Though if you do have a physical DMD, you can add a Color DMD widget to a slide in your on-screen window to see the Color DMD when you’re running your machine in virtual mode.)

Settings

```
type: color_dmd
width:
height:
source_display:
gain:
pixel_color:
dark_color:
shades:
dot_filter:
pixel_size:
blur:
bg_color:
```


type: color_dmd

Note: Color DMD widgets also have “common” widget settings for position, opacity, animations, style, etc. Those are not listed here, but are instead covered in [common widget settings](#) page.

Also remember that all widget settings can be controlled via [widget styles](#), rather than you having to set every setting on every widget.

width:

The width (in pixels) that the color DMD will be drawn on the slide. Note that this does *not* control how many pixels (or dots) are in the DMD, rather, it’s how big it is on the slide. (The number of dots on the DMD is controlled via the source display’s width setting.)

For example, you might have a window that’s 1024x768, and a source DMD display that’s 128x32.

If you set width: 896 for your color DMD widget, that means it will be 896 pixels wide in your 1024 window, and each drawn “dot” in the display will be 7 pixels wide in the window ($896 / 128 = 7$).

This setting is required.

height:

The height that the color DMD will be drawn on the slide. See the “width:” setting above for details.

source_display:

The name of the display (from your displays: section) that will be the source for the content of this color DMD widget. The default is dmd, which means you would need to have a display called “dmd” in the displays: section of your machine config.

gain:

A numeric multiplier that will be applied to every color channel of every pixel in this color DMD widget.

For example, if you set gain: 1.2, then a pixel on this color DMD’s source display that has a color of (100, 100, 100) will be drawn with the color (120, 120, 120). (Each element multiplied by 1.2).

Note that values above 255 will be capped at 255.

The default is 1.0 which means that the original colors are unchanged. You can play with this to act as a “poor man’s” brightness control, but values too far above or below 1.0 will probably look weird.

pixel_color:

A color value (either a color name or a list of RGB color values) that will be multiplied by every pixel from the source display before it’s drawn on the slide. This gives you the ability to “tint” the display

(the RGB channels in the `pixel_color` are separated applied to the corresponding RGB channels in the display).

The default is `None` which means this is disabled and the pixels show up with their regular colors.

dark_color:

Note: This feature is not currently implemented. TODO

This is the color of the pixels when they're "off" (black). Default is `221100`.

shades:

This is the number of shades each color channel will be reduced to. The default is `0` which disables it and uses the full 256 shades per color channel, meaning the color DMD widget will use have 256 shades each of red, green, and blue. (In other words, the default is standard 24-bit color for a total of 16.7m colors.)

Note that this setting can produce weird results depending on your source content. If you want an old school look, you might have better luck creating your videos and graphics with fewer colors and then not setting the shades option here.

Also note if you want to use full color (no shade reduction), it's better to set this to `0` and not `256` since `0` will disable this processing which will be less overhead.

dot_filter:

Enabled the "dot" look. Setting this to `False` means that the color DMD will not have dots. Default is `True`.

pixel_size:

The size of the individual "dots", expressed as a decimal relative to what their full size would be. A value of `1.0` will mean that each pixel will fill 100% of the space (e.g. no space in between), and it won't really look like separate pixels.

The default is `0.5`.

You can play with this setting (and the `blur`: setting below) to get a look that you like.

blur:

This is the radius of the "glow" of the pixels (when using `dot_filter: true`). This is expressed as a decimal relative to the size of the pixels. The default is `0.1` which means there's a 10% glow radius.

This will be in addition to the `pixel_size`:, so the defaults...

```
pixel_size: 0.5
blur: 0.1
```

... would result in the pixel being 50% of the space, the glow being 20% (10% on each side), leaving 30% for spacing in between the pixels.

bg_color:

The background color which is used for the spaces in-between the pixels when you have `dot_filter: true`. Default is 191919ff which is a dark gray color that's fully opaque.

If you set the alpha channel to be transparent (like 19191900), then the dots will appear “on top” of whatever else is on the slide behind the color DMD widget.

Examples

The example config files section of the documentation contains [examples of color DMD widgets](#).

More examples are in the [How to give your on-screen window the DMD “dot look”](#) guide.

DMD Widget

The DMD widget is used to render a [display](#) on a [slide](#) which looks like a classic monochrome DMD.

You can use the DMD widget to get an old school “DMD look” on your LCD display.

You can set the color of the dots to be whatever you want. (Default is orange, but you can make them red or purple or whatever.)

The DMD widget is almost identical to the [Color DMD Widget](#) widget except the DMD widget has the additional options to do the color reduction.

Note that the DMD Widget really is unrelated to whether you have a [physical DMD](#) in your machine. (Though if you do have a physical DMD, you can add a DMD widget to a slide in your on-screen window to see the DMD when you're running your machine in virtual mode.)

Settings

```
type: dmd
width:
height:
source_display:
luminosity:
pixel_color:
gain:
dark_color:
shades:
dot_filter:
pixel_size:
blur:
bg_color:
```

type: dmd

Note: DMD widgets also have “common” widget settings for position, opacity, animations, style, etc. Those are not listed here, but are instead covered in [common widget settings](#) page.

Also remember that all widget settings can be controlled via *widget styles*, rather than you having to set every setting on every widget.

width:

The width (in pixels) that the DMD will be drawn on the slide. Note that this does *not* control how many pixels (or dots) are in the DMD, rather, it's how big it is on the slide. (The number of dots on the DMD is controlled via the source display's width setting.)

For example, you might have a window that's 1024x768, and a source DMD display that's 128x32.

If you set width: 896 for your DMD widget, that means it will be 896 pixels wide in your 1024 window, and each drawn "dot" in the display will be 7 pixels wide in the window ($896 / 128 = 7$).

This setting is required.

height:

The height that the DMD will be drawn on the slide. See the "width:" setting above for details.

source_display:

The name of the display (from your displays: section) that will be the source for the content of this DMD widget. The default is dmd, which means you would need to have a display called "dmd" in the displays: section of your machine config.

luminosity:

In MPF, all display content is full color, but the DMD widget displays a range of monochrome colors to simulate a classic DMD. So MPF has to first reduce the color content to grayscale which is controlled by this setting.

Luminosity is a list of three decimal values that are the multipliers which are applied to each color change in the source content. used to reduce the full color

The default is:

```
luminosity: .299, .587, .184
```

which means that it converts each pixel to a grayscale color which is 29.9% of the red, 58.7% of the green, and 18.4% of the blue. (The reason these are not simply 1/3 of each color is because the human eye perceives the brightness of each color channel differently, so if it was a straight 1/3rd each then the resulting grayscale image would appear muddy.)

You can change these values from the default if you want to play with different settings, or just do not include a luminosity: setting to use the defaults.

pixel_color:

Controls what color the pixels will be of this DMD widget. The default is ff5500 which is a classic DMD orange.

This is essentially the color that becomes the “full on” pixel color, and then darker shades of it are proportional based on the grayscale conversion that was done previously.

gain:

A numeric multiplier that will be applied to every color channel of every pixel in this DMD widget.

For example, if you set `gain: 1.2`, then a pixel on this DMD’s source display that has a color of (100, 100, 100) will be drawn with the color (120, 120, 120). (Each element multiplied by 1.2).

Note that values above 255 will be capped at 255.

The default is 1.0 which means that the original colors are unchanged. You can play with this to act as a “poor man’s” brightness control, but values too far above or below 1.0 will probably look weird.

This is applied after the `luminosity:` and `pixel_color:` processing and can help you tweak the look of the DMD widget.

dark_color:

Note: This feature is not currently implemented. TODO

This is the color of the pixels when they’re “off” (black). Default is 221100.

shades:

This is the number of shades each color channel will be reduced to. The default is 16 which means that the DMD widget will use have 16 levels of brightness between black and the `pixel_color:` you specified.

Set it to 0 if you want to disable it and keep the original range of shades.

Note that this setting can produce weird results depending on your source content. If you want an old school look, you might have better luck creating your videos and graphics with fewer colors and then not setting the shades option here.

dot_filter:

Enabled the “dot” look. Setting this to False means that the DMD will not have dots. Default is True.

pixel_size:

The size of the individual “dots”, expressed as a decimal relative to what their full size would be. A value of 1.0 will mean that each pixel will fill 100% of the space (e.g. no space in between), and it won’t really look like separate pixels.

The default is 0.5.

You can play with this setting (and the `blur:` setting below) to get a look that you like.

blur:

This is the radius of the “glow” of the pixels (when using `dot_filter: true`). This is expressed as a decimal relative to the size of the pixels. The default is 0.1 which means there’s a 10% glow radius.

This will be in addition to the `pixel_size:`, so the defaults...

```
pixel_size: 0.5
blur: 0.1
```

... would result in the pixel being 50% of the space, the glow being 20% (10% on each side), leaving 30% for spacing in between the pixels.

bg_color:

The background color which is used for the spaces in-between the pixels when you have `dot_filter: true`. Default is 191919ff which is a dark gray color that’s fully opaque.

If you set the alpha channel to be transparent (like 19191900), then the dots will appear “on top” of whatever else is on the slide behind the DMD widget.

Examples

The example config files section of the documentation contains *examples of DMD widgets*.

More examples are in the *How to give your on-screen window the DMD “dot look”* guide.

Ellipse Widget

The ellipse widget is used to draw a solid ellipse (including circles) on a *slide*.

It can also be used to draw “wedges” (pie slices) or ellipses with sections missing (like Pac Man).

Note that ellipses are always solid. If you want an elliptical outline, use the *Bezier Curve Widget*.

Here’s an example:

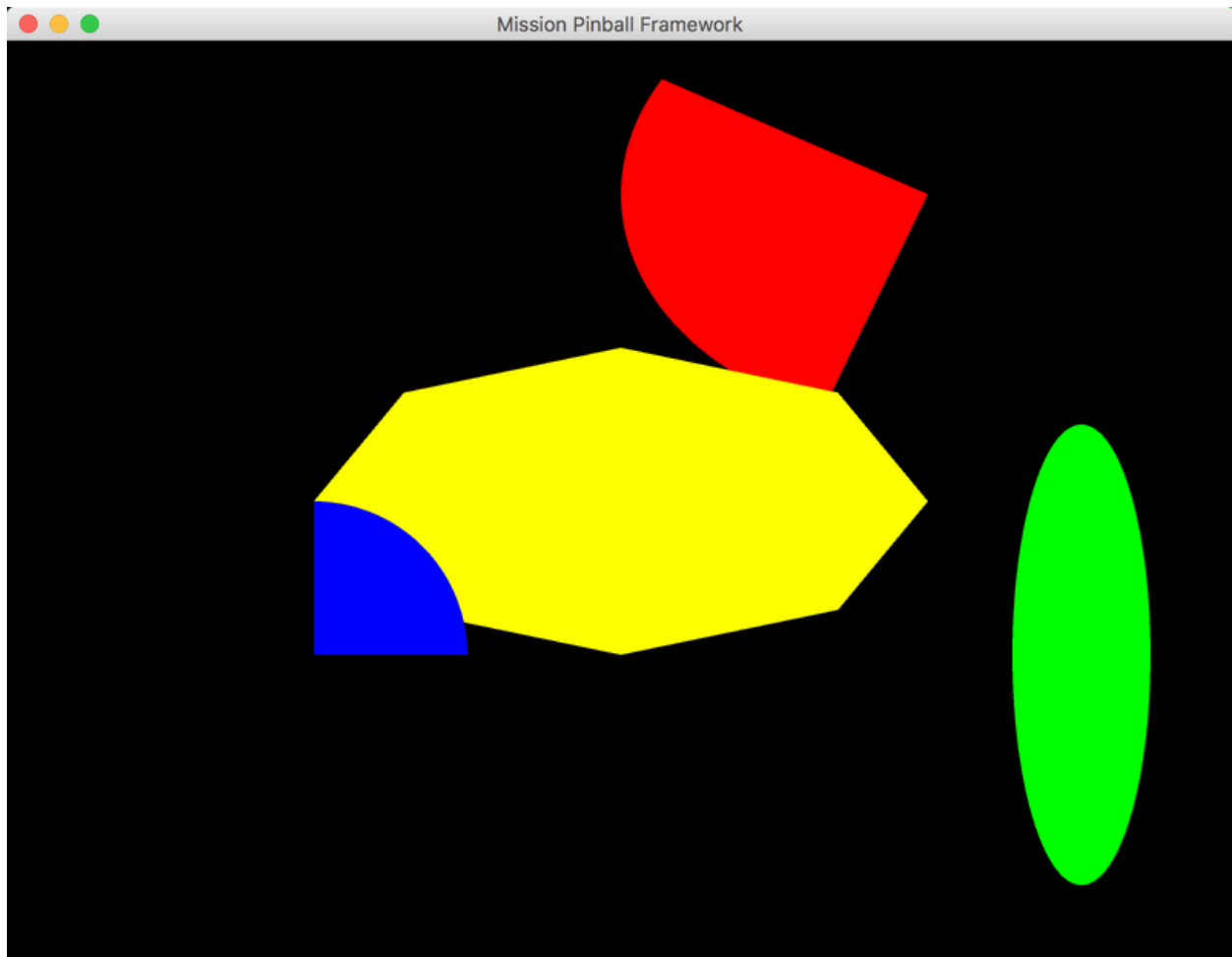
```
#config_version=4

slide_player:
  mc_ready:
    ellipse_example:
      - type: ellipse
        x: 200
        y: 200
        width: 200
        height: 200
        color: blue
        angle_start: 0
        angle_end: 90
      - type: ellipse
        x: 400
        y: 300
        width: 400
```



```
height: 200
color: yellow
segments: 8
- type: ellipse
  x: 600
  y: 500
  width: 400
  height: 300
  color: red
  angle_start: 200
  angle_end: 300
- type: ellipse
  x: 700
  y: 200
  width: 90
  height: 300
  color: lime
```

And the result:



Settings

```
width:  
height:  
segments:  
angle_start:  
angle_end:
```

Note: Ellipse widgets also have “common” widget settings for position, opacity, animations, color, style, etc. Those are not listed here, but are instead covered in [common widget settings](#) page.

Also remember that all widget settings can be controlled via [widget styles](#), rather than you having to set every setting on every widget.

type: ellipse

Tells MPF that this is an ellipse widget. This setting is required when using ellipse widgets.

width:

The width (in pixels) of this ellipse. This setting is required.

The width: and height: settings set the bounding box that the ellipse will be drawn in. If you want a circle, set the width and height to be the same.

height:

The height (in pixels) of this ellipse. This setting is required.

segments:

The number of segments that will make up the ellipse. More segments will create a smoother edge, but depending on the size of your display and the size of the ellipse, you might not see much of a difference.

The default is 180.

angle_start:

The angle, between 0-360, where the ellipse will start. The default is 0.

angle_end:

The angle, between 0-360, where the ellipse will start. The default is 360.

Note that a start angle of 0 and an end angle of 360 will create a complete solid ellipse.

Line Widget

The line widget is used to draw a straight line on a *slide*. (Note that if you want to draw a curved line, you can use the *Bezier Curve Widget*.)

Here's an example:

```
#config_version=4

slide_player:
  mc_ready:
    line_example:
      - type: line
        points: 0, 300, 800, 300
      - type: line
        points: 0, 100, 800, 100
      - type: line
        points: 400, 95, 400, 0
        color: red
        thickness: 5
        cap: square
      - type: line
        points: 100, 500, 150, 550, 200, 450
        color: lime
        thickness: 2
      - type: line
        points: 500, 150, 600, 350, 650, 200
        color: blue
        close: yes
        thickness: 3
```

And the results:



Settings

```
type: line
points:
thickness:
cap:
joint:
cap_precision:
joint_precision:
close:
```

Note: Line widgets also have “common” widget settings for position, opacity, animations, color, style, etc. Those are not listed here, but are instead covered in [common widget settings](#) page.

Also remember that all widget settings can be controlled via [widget styles](#), rather than you having to set every setting on every widget.

type: line

Tells MPF that this is a line widget. This setting is required when using line curve widgets.

points:

A list of point pairs which make up the line, expressed in x/y pairs (so the number of items here has to be even).

For example:

```
points: 10, 10, 200, 50, 300, 200
```

This would draw a line starting at (10,10) and going to (200, 50), and then from there, going to (300,200). If you just want a single straight line, then you would enter 4 values here: the x/y of the start and the x/y of the end.

thickness:

The thickness of the line. You'll probably have to play with different settings to get it right. The default is 1.0, so 2.0 is twice as thick as the default, 0.5 is half as thick, etc.

cap:

Determine the cap of the line, defaults to 'round'. Can be one of 'none', 'square' or 'round'.

joint:

Determine the join of the line, defaults to 'round'. Can be one of 'none', 'round', 'bevel', 'miter'.

cap_precision:

Integer, defaults to 10.

Number of segments for drawing the "round" joint, defaults to 10. The joint_precision must be at least 1.

joint_precision:

Integer, defaults to 10.

Number of segments for drawing the "round" joint, defaults to 10. The joint_precision must be at least 1.

close:

Boolean (True/False), default is False.

If True, the line will be closed.

Examples

The example config files section of the documentation contains [examples of line widgets](#).

Points Widget

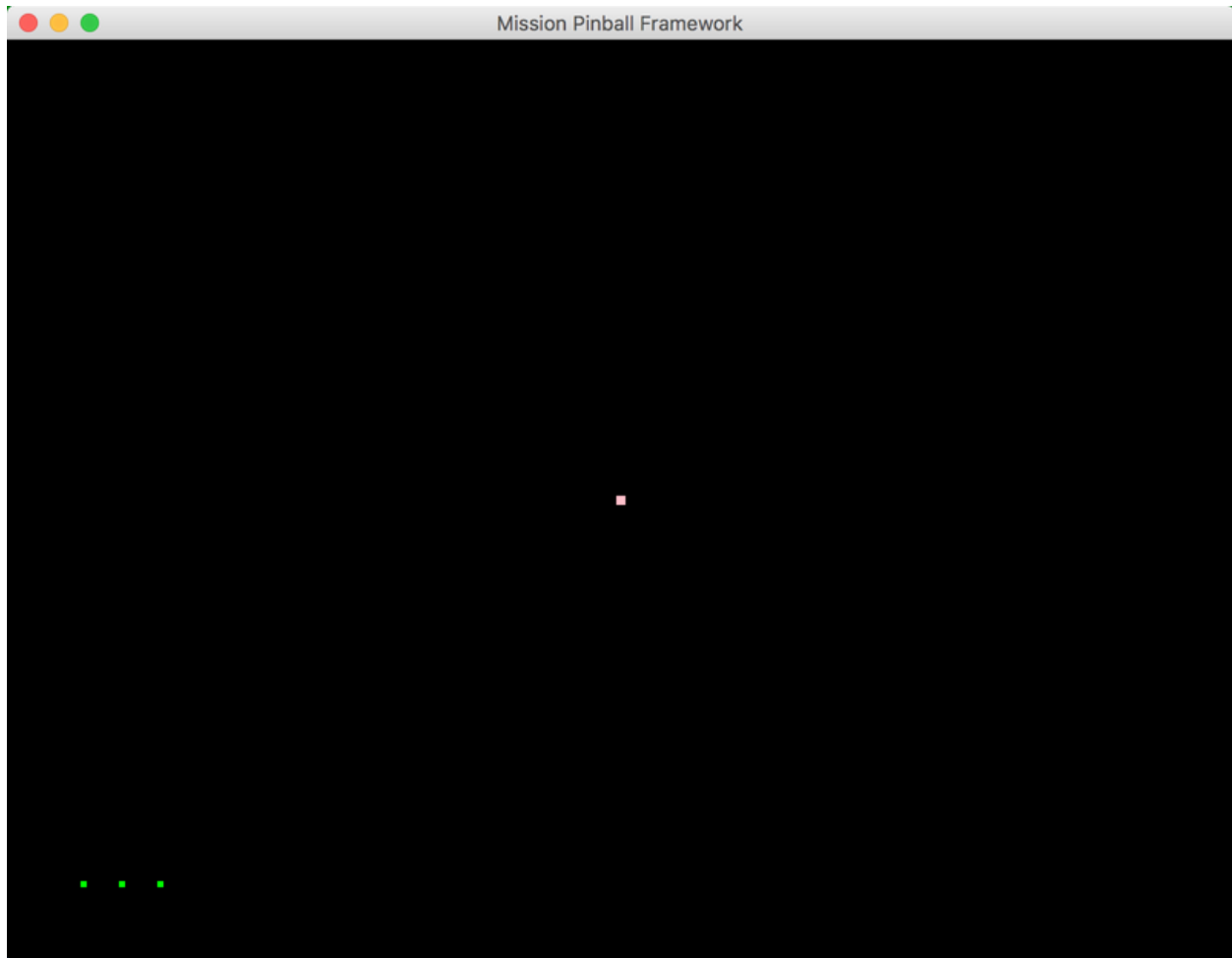
The points widget is used to draw points (individual square points) on a slide.

Here's an example:

```
#config_version=4

slide_player:
  mc_ready:
    points_example:
      - type: points
        points: 50, 50, 75, 50, 100, 50
        pointsize: 2
        color: lime
      - type: points
        points: 400, 300
        pointsize: 3
        color: pink
```

Which results in the following:



Settings

```
type: points
points:
pointsize:
```

Note: Points widgets also have “common” widget settings for position, opacity, animations, color, style, etc. Those are not listed here, but are instead covered in [common widget settings](#) page.

Also remember that all widget settings can be controlled via [widget styles](#), rather than you having to set every setting on every widget.

type: points

points:

A list of the x,y coordinates of pairs of points.

pointsize:

Floating-point number, default is 1.0.

The distance from the center of the point to the edge, so a value of 1.0 makes a point that's two pixels wide. (This is kind of like the radius, though points are square so it's not technically the radius. Probably there's some fancy math name for it.)

Quad Widget

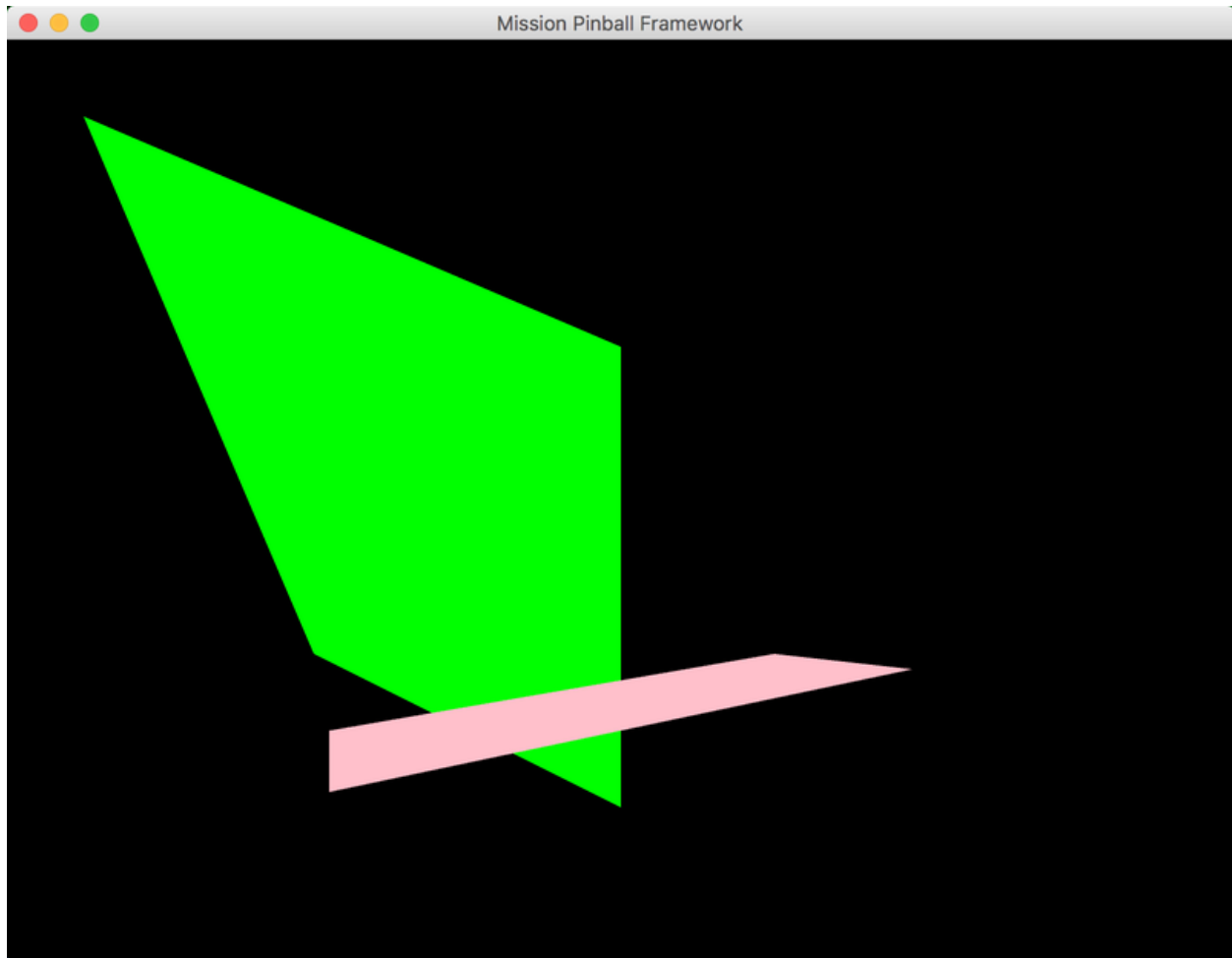
The quad widget is used to draw solid polygons on a slide.

Here's an example:

```
#config_version=4

slide_player:
  mc_ready:
    bezier_example:
      - type: quad
        points: 210, 110, 210, 150, 500, 200, 590, 190
        color: pink
      - type: quad
        points: 50, 550, 400, 400, 400, 100, 200, 200
        color: lime
```

Which results in the following:



Settings

```
type: quad  
points:
```

Note: Quad widgets also have “common” widget settings for position, opacity, animations, color, style, etc. Those are not listed here, but are instead covered in [common widget settings](#) page.

Also remember that all widget settings can be controlled via [widget styles](#), rather than you having to set every setting on every widget.

type: quad

Tells MPF this is a quad widget.

points:

A list of 8 values representing x,y coordinate pairs for the four corners of the quad.

A list of the x,y coordinates of the corners. Note that to have a normal four-cornered shape, the corners need to be in order. You can start with any one and go clockwise or counter-clockwise, but if you enter the corners in a mixed order like 1, 3, 2, 4 then it's possible your quad will fold over itself and look weird.

Rectangle Widget

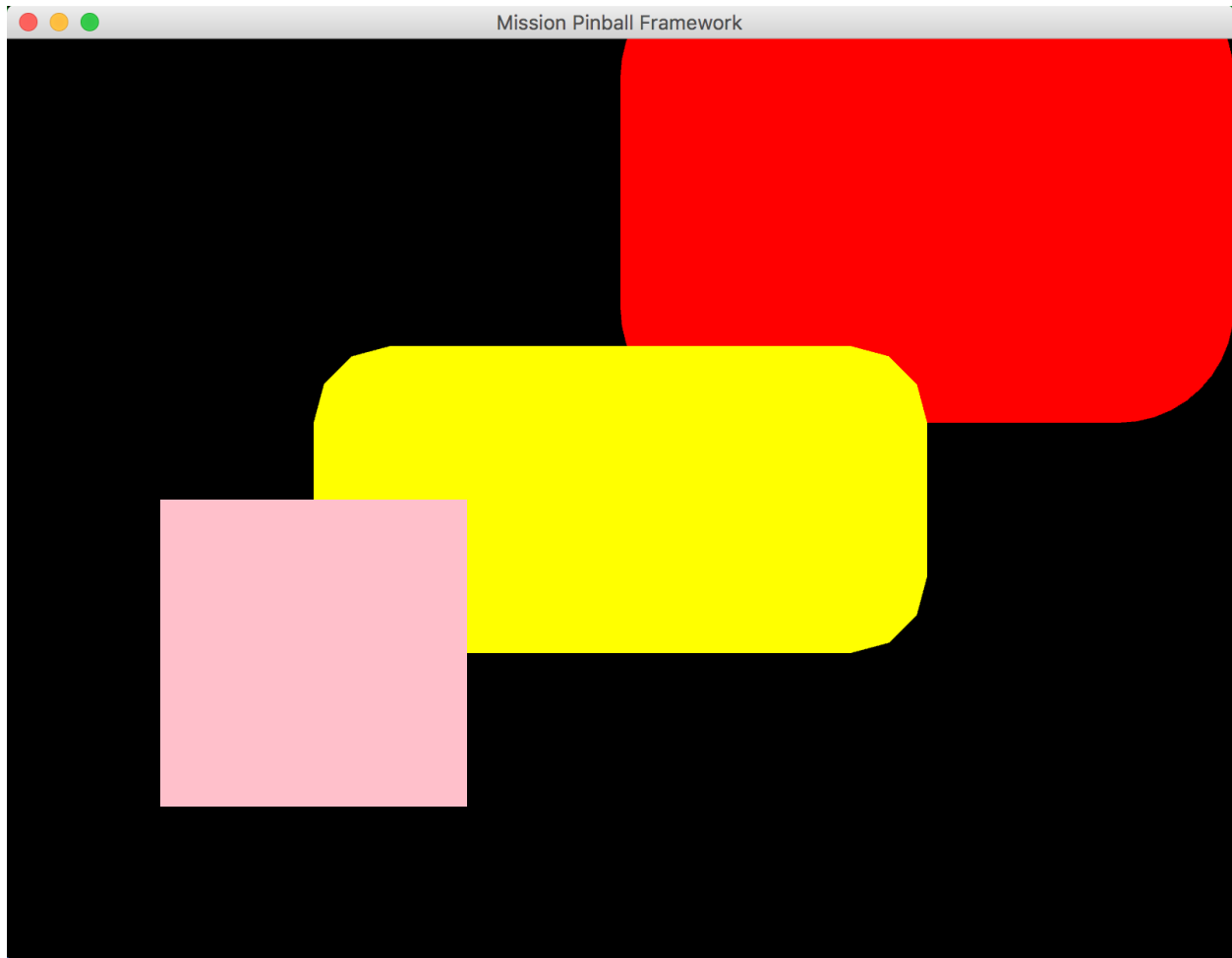
The rectangle widget is used to draw a rectangle (or rounded rectangle) on a slide. Remember that a square is just a rectangle whose height and width are the same.

Here's an example:

```
#config_version=4

slide_player:
  mc_ready:
    rectangle_example:
      - type: rectangle
        x: 200
        y: 200
        width: 200
        height: 200
        color: pink
      - type: rectangle
        x: 400
        y: 300
        width: 400
        height: 200
        corner_radius: 50
        corner_segments: 3
        color: yellow
      - type: rectangle
        x: 600
        y: 500
        width: 400
        height: 300
        corner_radius: 75
        color: red
```

Which results in the following:



Settings

```
type: rectangle
width:
height:
corner_radius:
corner_segments:
```

Note: Rectangle widgets also have “common” widget settings for position, opacity, animations, color, style, etc. Those are not listed here, but are instead covered in [common widget settings](#) page.

Also remember that all widget settings can be controlled via [widget styles](#), rather than you having to set every setting on every widget.

width:

The width of the rectangle, in pixels.

height:

The height of the rectangle, in pixels.

corner_radius:

Number value of the radius of the corners (in pixels). Default is 0 which means sharp square corners.

corner_segments:

For rectangles with rounded corners (where `corner_radius:` is greater than 1), how many individual segments should make up the corner. The more segments, the smoother the corner is.

Default is 10.

Slide Frame Widget

The slide frame widget is used to create a “frame” on a [slide](#) that is used to hold other slides. (Think of this like a picture-in-picture kind of thing.)

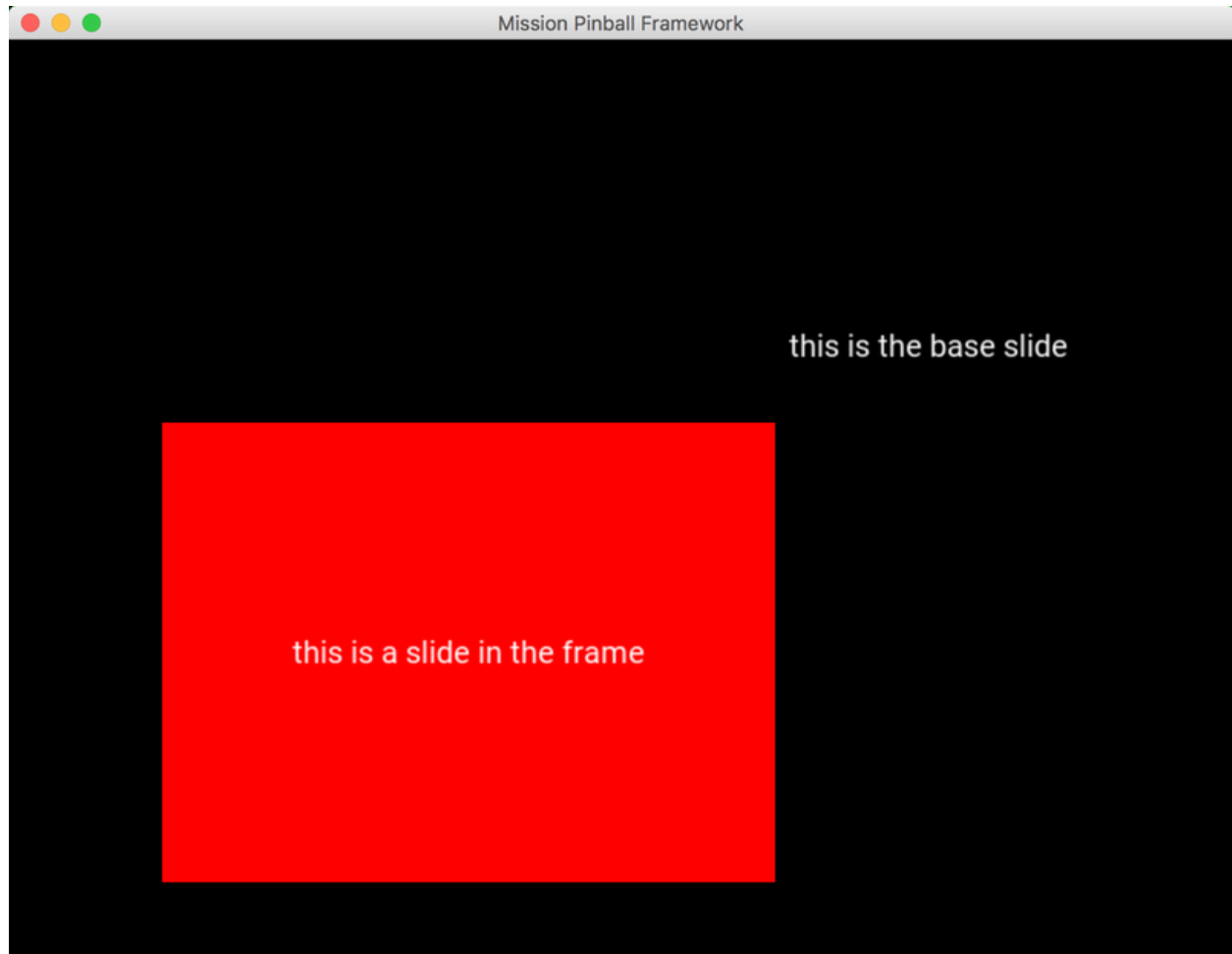
Here’s an example:

```
#config_version=4

slides:
  base_slide:
    - type: slide_frame
      name: my_frame
      width: 400
      height: 300
      x: 300
      y: 200
    - type: text
      text: this is the base slide
      x: 600
      y: 400
  frame_slide:
    widgets:
      - type: text
        text: this is a slide in the frame
    background_color: red

slide_player:
  mc_ready.1: base_slide
  mc_ready.2:
    frame_slide:
      target: my_frame
```

And the result:



Settings

```
type: slide_frame
name:
width:
height:
```

Note: Slide frame widgets also have “common” widget settings for position, opacity, animations, color, style, etc. Those are not listed here, but are instead covered in [common widget settings](#) page.

Also remember that all widget settings can be controlled via [widget styles](#), rather than you having to set every setting on every widget.

name:

The name of your frame. This name will be available as a `target: name` in other areas of your configs (just like displays) when you want to target a slide to this frame.

More information on display targets is [here](#).

width:

The width of the frame in pixels.

height:

The height of the frame in pixels.

Text Input Widget

The text input widget is a special widget which lets the player use the flipper buttons to cycle through letters and numbers and to select them. This is used in the high score name entry and the service mode.

Currently the text input widget flashes a cursor over the selected letter, and the player hitting the flipper buttons changes the letter in place. In the future, we'll add an option to show all the letters on the screen in a long list as well.

Settings

Here are the list of settings you can use for text_input widgets:

```
type: text_input
key:
char_list:
max_chars:
initial_char:
keep_selected_char:
dynamic_x:
dynamic_x_pad:
shift_left_event:
shift_right_event:
select_event:
abort_event:
force_complete_event:
font_size:
font_name:
bold:
italic:
halign:
valign:
```

Note: Text widgets also have “common” widget settings for position, opacity, animations, color, style, etc. Those are not listed here, but are instead covered in [common widget settings](#) page.

Also remember that all widget settings can be controlled via [widget styles](#), rather than you having to set every setting on every widget.

type: text_input

Tells MPF that this is a text_input widget. This setting is required when using text_input widgets.

key:

single

char_list:

String value, default is ABCDEFGHIJKLMNOPQRSTUVWXYZ_ - \.

A list of all the characters that are available to be chosen by the player as they're entering their name or initials. The order they are here is the order they show up as the uses scrolls left or right. If you want to add, remove, or change any of the defaults, just add a new char_list: setting to this text_input widget and completely replace the default list with your own list.

Note that "back" and "end" characters will automatically be added to the end of this list.

max_chars:

Integer value, default is 3.

How many characters can be entered into this text input field.

initial_char:

Single character value. Default is A.

The character from your char_list: that you want to be the initial character selected before the player starts entering their name.

keep_selected_char:

Boolean (True/False or Yes/No), default is True.

When a player hits the start button to select a character and then the cursor moves to the next position, should the selected character stay with the character they just selected, or should it go back to the initial_char:?

dynamic_x:

Boolean (True/False or Yes/No), default is True.

If True, then the x position of this text widget will be updated as characters are selected and entered. If False, then the widget's x position will not change, and additional characters will be added to the right edge.

In other words, if you plan to center this widget, set this to True. If you plan on left justifying it, set it to False.

dynamic_x_pad:

Integer value. Default is 0.

If you're using the `dynamic_x:` setting above, this is the number of additional pixels that will be added to the total width of the widget to calculate the dynamic x position.

shift_left_event:

The event that, when posted, will shift the selected character from the *char_list* to the left. Default is `sw_left_flipper`.

shift_right_event:

The event that, when posted, will shift the selected character from the *char_list* to the right. Default is `sw_right_flipper`.

select_event:

The event that, when posted, will select (or "enter") the currently highlighted character and move the cursor to the next position. Default is `sw_start` (which is the event that's posted when a switch tagged with *start* is hit).

abort_event:

The event that, when posted, will abort (or cancel) the character entry process. Default is `sw_esc` (which is the event that's posted when a switch tagged with *esc* is hit).

force_complete_event:

The event that, when posted, will mark the text entry process as complete, even if the player hasn't entered all their characters yet. Default is `None`.

font_size:

Same as the `font_size:` setting for the *Text Widget*. See that documentation for usage.

font_name:

Same as the `font_name:` setting for the *Text Widget*. See that documentation for usage.

bold:

Same as the `bold:` setting for the *Text Widget*. See that documentation for usage.

italic:

Same as the italic: setting for the *Text Widget*. See that documentation for usage.

halign:

Same as the halign: setting for the *Text Widget*. See that documentation for usage.

valign:

Same as the valign: setting for the *Text Widget*. See that documentation for usage.

anchor_y: baseline

Text input widgets have an additional baseline option in addition to the other baseline options detailed in the *common widget settings* documentation.

Triangle widget

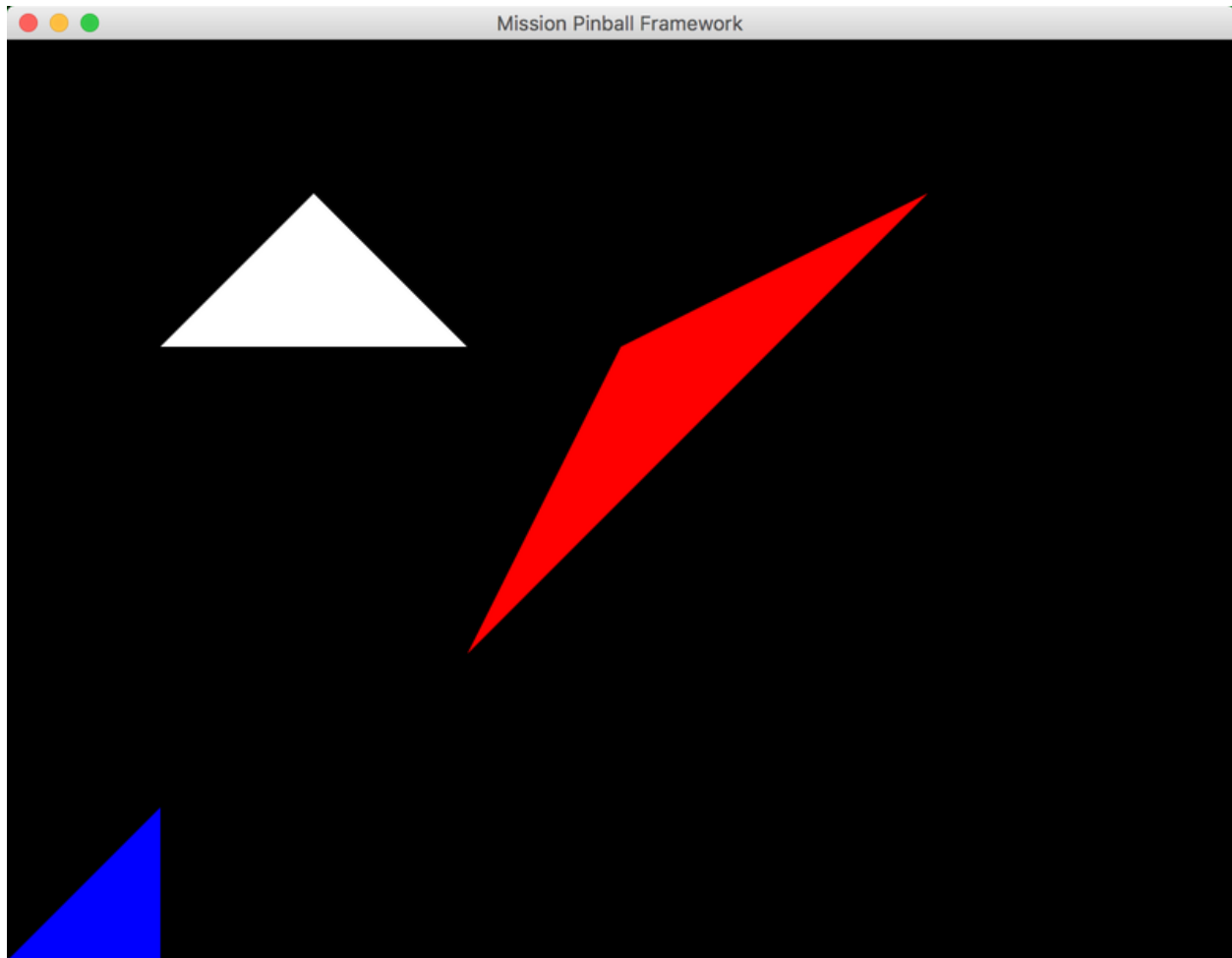
The triangle widget is used to draw triangles on a *slide*.

Here's an example:

```
#config_version=4

slide_player:
  mc_ready:
    triangle_example:
      - type: triangle
        color: blue
        points: 0, 0, 100, 0, 100, 100
      - type: triangle
        points: 400, 400, 300, 200, 600, 500
        color: red
      - type: triangle
        points: 200, 500, 100, 400, 300, 400
```

The example above results in the following:



Settings

```
type: triangle
points:
```

Note: Triangle widgets also have “common” widget settings for position, opacity, animations, color, style, etc. Those are not listed here, but are instead covered in [common widget settings](#) page.

Also remember that all widget settings can be controlled via [widget styles](#), rather than you having to set every setting on every widget.

type: triangle

Tells MPF that this is a triangle widget.

points:

A list of six numbers which are the the x,y coordinates for each of the three corners. For example, points: 400, 300, 200, 300, 400, 200 would be a triangle with one corner at (400, 300), another corner at (200, 300), and the final corner at (400, 200).

Common Settings that Apply to All Widget Types

The following settings are “common” settings that apply to all *types of widgets*:

```
type:
x:
y:
anchor_x:
anchor_y:
opacity:
z:
animations:
reset_animations_events:
color:
style:
adjust_top:
adjust_bottom:
adjust_left:
adjust_right:
expire:
key:
```

type:

Specifies the type of widget, such as type: text or type: image. This setting is required (since MPF needs to know what kind of widget it is).

x:

The horizontal position of the widget on the slide. This setting can be entered in several ways:

- Absolute position: a number like 0, 200, or -50
- Relative position entered as a percent: 20% or -12%
- A positional keyword: left, center, or right
- A combination of positional keyword and a value: left+10%, right-5

The default value is center.

See the [widget positioning](#) documentation for full details on how to position a widget on a slide.

y:

The vertical position of the widget on a slide. This setting can be entered in several ways:

- Absolute position: 0, 200
- Relative position entered as a percent: 20%
- A positional keyword: top, middle, or bottom
- A combination of positional keyword and a value: bottom+10%, top-5

The default value is middle.

See the [widget positioning](#) documentation for full details on how to position a widget on a slide.

anchor_x:

The horizontal “anchor” point of the widget which specifies what point on the widget is used for the horizontal positioning. Valid options are left, center (or middle), and right.

The default value is center.

See the [widget positioning](#) documentation for full details on how to position a widget on a slide.

anchor_y:

The vertical “anchor” point of the widget which specifies what point on the widget is used for the vertical positioning. Valid options are top, middle (or center), and bottom.

The default value is middle.

See the [widget positioning](#) documentation for full details on how to position a widget on a slide.

opacity:

A value from 0 to 1 which controls the opacity (or transparency) of the widget. You can use decimal values between 0 and 1 for partial transparency.

- Completely transparent (e.g. invisible): 0
- Completely opaque (e.g. normal): 1
- 50% transparent: 0.5

The default value is 1.

Note that some widget types allow you to set values greater than 1, which will have the effect of making the “glow” of the widget brighter. This isn’t a great effect, but it could be useful in some cases.

Caution: Note that opacity values are 0 to 1, not 0 to 100. If you set opacity: 100 then that’s really like 10,000% opacity and your widget will probably look really weird.

z:

Specifies the “layer” or “z-order” of the widget. Higher z values mean that if parts of two widgets overlap on the slide, the one with the higher value will be drawn on top of the one with the lower value. (e.g. z: 100 will be drawn on top of z: 99.)

The default drawing order of widgets is controlled by the order the widgets are listed in the slide, widget group, or `widget_player` config entry. So usually you don't need to manually set the `z` value, instead just put them in the order you want in your config.

However, being able to manually set the `z` value is nice if you want to add a widget to an existing slide and have it appear above and below certain widgets.

The default `z` value is 0.

If you do want to add a widget with a particular `z` order to an existing slide, you'll probably have to set those existing widgets to a `z` value other than 0.

animations:

Contains a list of events and the animated widget properties and steps for each of those events. See the [widget animation documentation](#) for details.

reset_animations_events:

A list of events which are used to reset the widget to its original settings and stop all running animations. See the [widget animation documentation](#) for details.

Note that this seems like a grammatical error, since it's "animations events", but it's correct in this case because this setting is for a list of events that resets the widget animations (since animations themselves are a list of separate animations).

color:

Sets the color (and opacity) of the widget. This is pretty straightforward for most widget types (like text and the various shape widgets). If you set this for an image or video widget, it will have the effect of "tinting" the widget with the color you specified.

You can enter this as a hex color string or a color name. See the [color instructions](#) for details.

If you're entering hex strings, you can enter either 6 or 8 characters. The first six characters are RGB values (00-ff each), and the final is the opacity (00-ff). If you don't enter an opacity, ff (fully opaque) is used.

The default value is ffffffff which is white at 100% opacity.

style:

The name of the style you want to apply to this widget. Note that styles must be previously defined someone in your config in order to use them. Also you can override any setting from the style by also manually including it in the widget config. See the [style documentation](#) for details.

The default value is None which means no style is used.

adjust_top:

Redefines the top point of the widget when used in positioning to compensate for widgets that have visual top points that don't align with their technical top points.

The default value is None.

See the [widget positioning](#) documentation for full details on how widget positioning offset adjustments work.

adjust_bottom:

Redefines the bottom point of the widget when used in positioning to compensate for widgets that have visual bottom points that don't align with their technical bottom points.

The default value is None.

See the [widget positioning](#) documentation for full details on how widget positioning offset adjustments work.

adjust_left:

Redefines the left point of the widget when used in positioning to compensate for widgets that have visual left points that don't align with their technical left points.

The default value is None.

See the [widget positioning](#) documentation for full details on how widget positioning offset adjustments work.

adjust_right:

Redefines the right point of the widget when used in positioning to compensate for widgets that have visual right points that don't align with their technical right points.

The default value is None.

See the [widget positioning](#) documentation for full details on how widget positioning offset adjustments work.

expire:

Sets a time (such as `expire: 2s`) for this widget to be removed from the slide once it's added to it. This is useful with the `widget_player` when you want to add a widget to an existing slide and then remove it again.

The default value is None.

key:

Specifies a “key” name which is assigned to the widget which you can later use to target this widget if you want to do something to do (change a property, remove it, etc.) You don’t need to specify keys for every widget—only for the ones that you want to target later.

See the [documentation on widget keys](#) for details.

Adding widgets to a slide

Now that you know what widgets are, it’s time to look at how you can actually use them.

Option 1. Define widgets when you define a slide

The easiest way to create and use widgets is to include them in the slide configuration when the slide itself is created.

You can do this when you define a slide in the `slides:` section of your config, or when you show a slide in the `slide_player:` section of your config. See the [How to create slides](#) guide for details.

Option 2. Use the “widget player”

If you want to add a widget (or a groups of widgets) to an existing slide, you can use the `widget_player:`. You can define your widgets there, or you can use widgets that you’ve *pre-defined*.

How to position widgets on slides

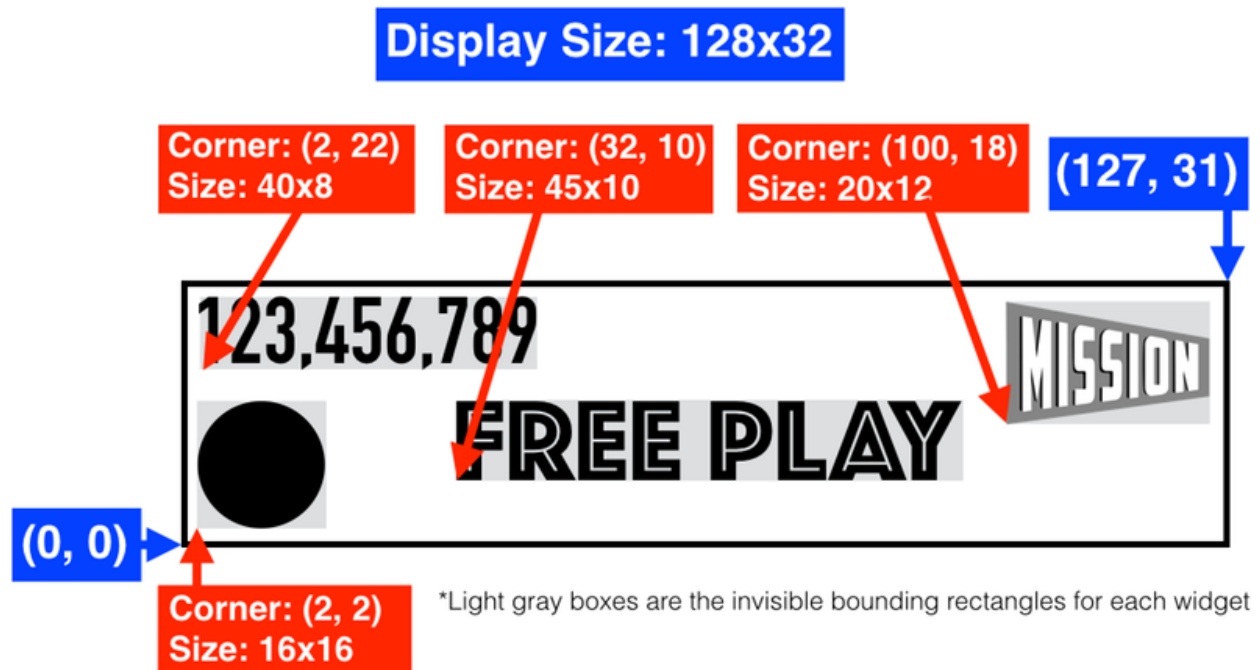
Probably the most important thing to know about putting widgets on slides is how to position them.

1. Understanding MPF display coordinates

At the most basic level, every display slide has a resolution (always conveyed in the order width, then height), and widgets have a position on slide (horizontal, then vertical).

- The dimensions of the slide are always described *width* (x), then *height* (y). (So a 128x32 display is 128 pixels wide and 32 pixels tall.)
- The “zero” position is the lower-left corner. (Just like an x-y cartesian coordinate graph from school.)
- Since the (0, 0) position is the actual location of the lower-left corner pixel, the upper-right pixel is actually one less than the width and height of your slide. (e.g. a display that’s 128 pixels wide has x positions 0 through 127.)
- A widget’s position is always described *horizontal* (x), then *vertical* (y). So a widget at position (10, 20) is 10 pixels in from the left edge and 20 pixels up from the bottom.

Here’s a simple example that illustrates this:



By the way, in MPF, the actual “pixel size” of the display as MPF sees it is separate from actual pixels of the physical display. So you could have a display in MPF that’s 400x300 pixels, but you show that full size on an LCD that’s 1920x1200 pixels. MPF will automatically scale the logical display to fit in the size of the window you configure on the physical display. This is known as “resolution independence”, and is nice if you ever have to replace your LCD in the future and the new one you buy doesn’t have the same resolution as your old one.

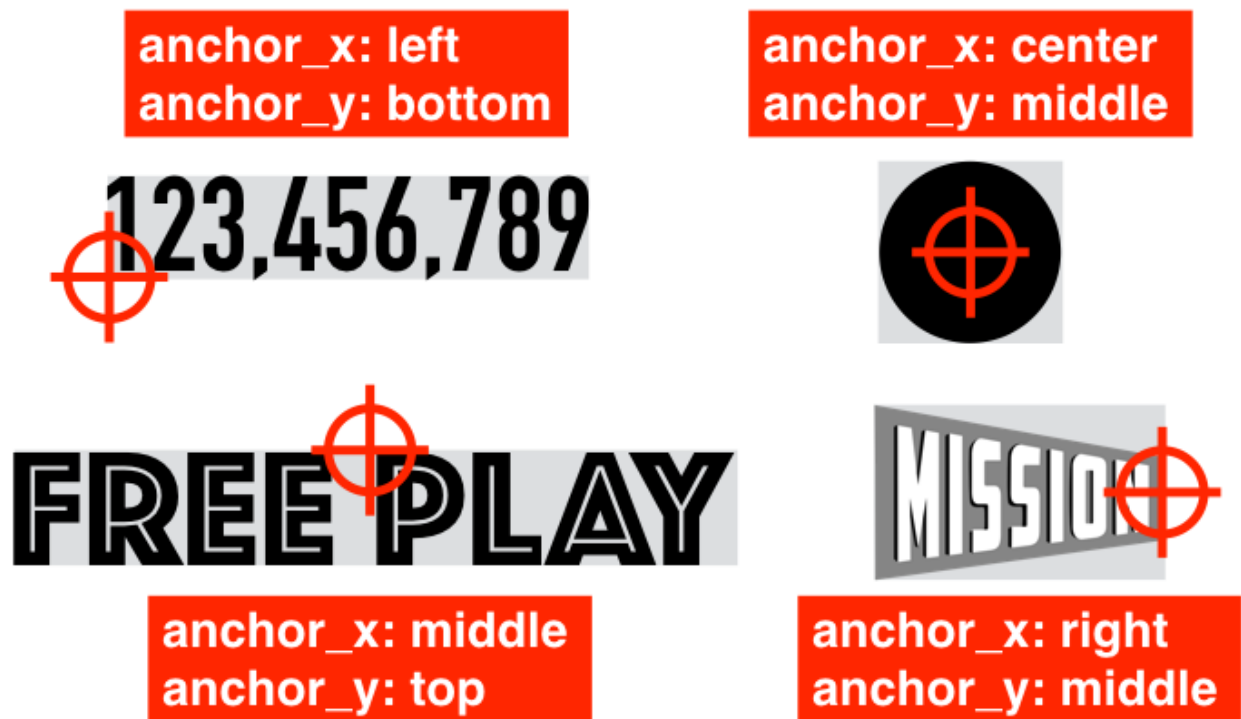
2. Understanding widget “anchors”

In the diagram from the first step, the “position” of each widget is set based on its lower-left corner. In real life, if you had to position every widget based on its lower-left corner all the time, you’d go crazy! For example, to “center” a widget, you’d have to calculate what the x and y offsets were and then do some math, and then if you animated the widget’s size you’d have to recalculate it. . . it would be a mess!

Fortunately MPF does all this math for you.

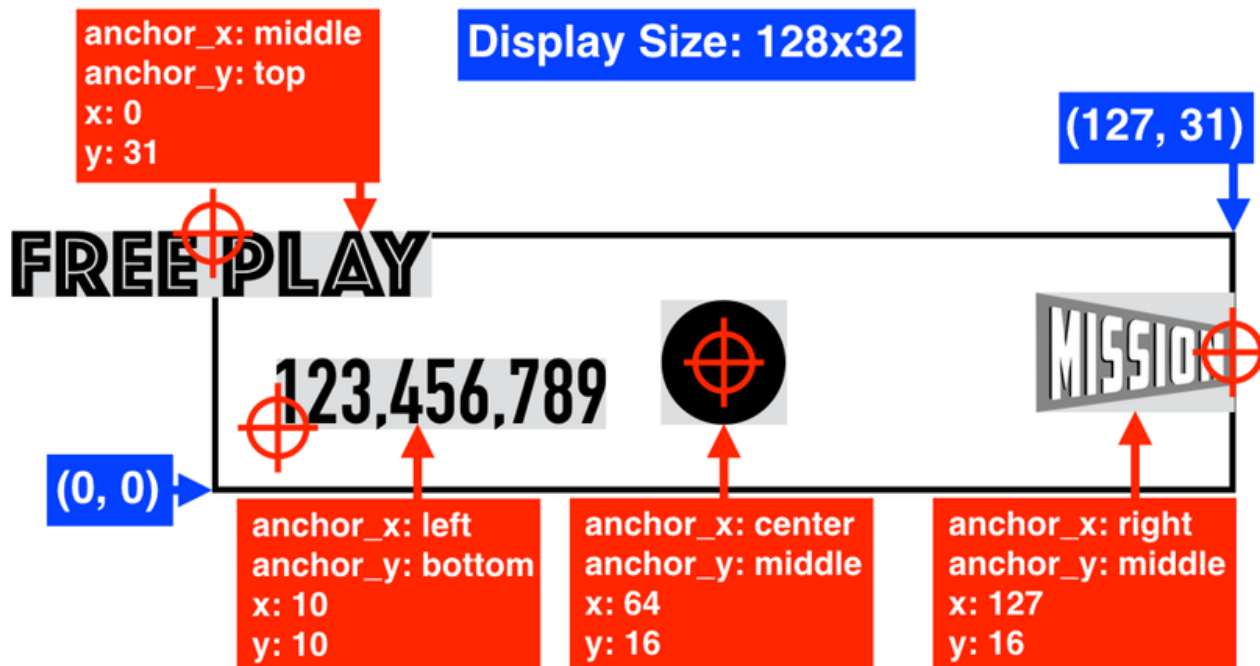
When you configure a widget in MPF, you can config its “anchor” point (both `anchor_x` for the horizontal anchor and `anchor_y` for the vertical anchor.)

A widget’s anchor setting tells MPF what point on the widget is used to position it on the slide. Here are some examples which show how various anchor settings are applied to different widgets. The red bulls-eye target represents the point that’s used by MPF to position that widget with each type of anchor settings.



3. Combing anchors and widget positioning

Now that you know how the coordinates and anchors work, let's look at some examples that combine these two concepts:



In the diagram above, you can see how the bulls-eye anchor target is the actual point of the widget that is positioned with each widget's x: and y: settings.

You'll also notice that widgets can be fully or partially be positioned outside the boundaries of a slide. (This is useful if you want to animate a widget "entering" the slide from off screen—you'd position the widget so it's outside the bounds of the visible window and then animate it moving on.) Also note that positioning can be negative. Negative x values are off the left edge of the slide, and negative y values are off the bottom.

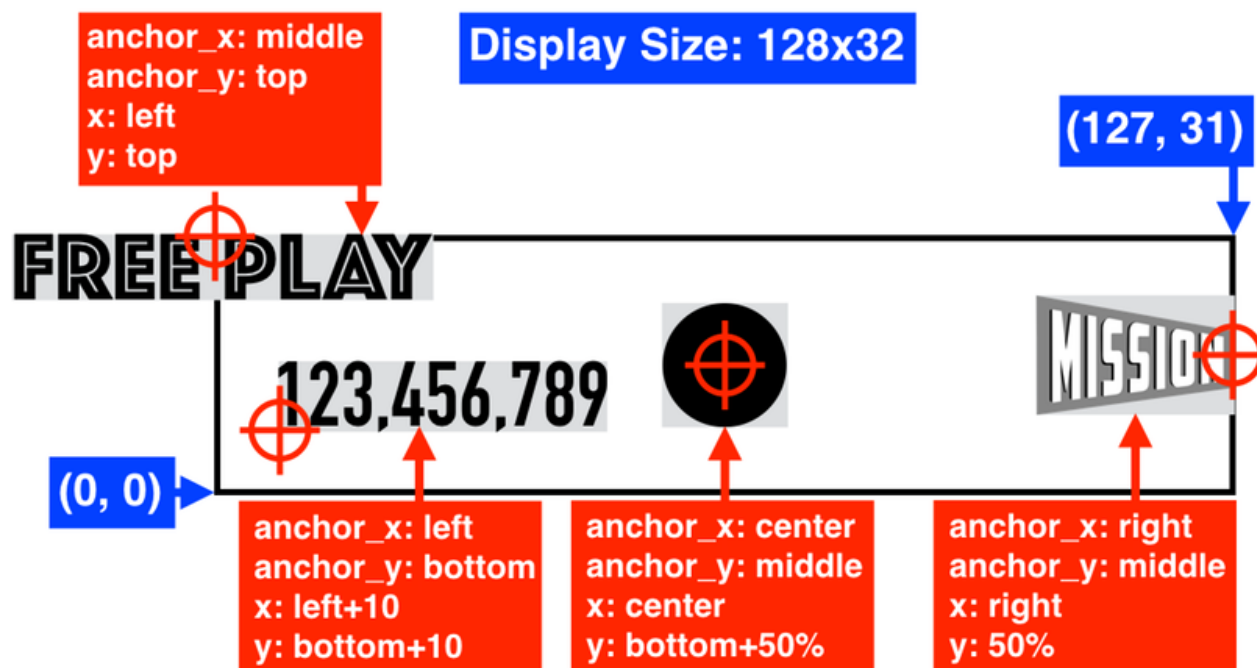
As you look at this example, you can probably start to see that different anchors make sense for different types of positioning. For example, if you have several widgets that you'd like to left-align, then it makes sense to set their anchors to `anchor_x: left` and positioning them based on their left edge.

By default, MPF uses the center of the widget for the anchor. This is what you get if you do not include an `anchor_x:` or `anchor_y:` setting. (Also the terms `middle` and `center` are interchangeable in all widget anchor and positioning settings.)

4. Relative positioning

Even though anchors are powerful, it can still be kind of confusing to position widgets based solely on `x:` and `y:` pixel values. After all, you constantly have to think about how big your display is and do lots of math to get your values set.

Fortunately MPF can use relative positions for a widget's `x:` and `y:` values, as show here:



There are a lot of different options in this diagram, so let's go through them one-by-one.

First, for `x:` values, you can use:

- `x: left` - Positions the anchor of the widget at the left edge of the slide
- `x: center` - Positions the anchor of the widget in the horizontal center
- `x: right` - Positions the anchor on the right edge

You can also use percentage values. The percentages are automatically calculated based on the width of the slide. So if you set `x: 50%` and your slide is 800 pixels wide, the x value will be 400. (`x: 50%` is the

same as x: center.)

For y: values, you can use:

- y: top - Positions the anchor of the widget at the top of the slide.
- y: middle - Positions the anchor of the widget in the vertical middle.
- y: bottom - Positions the anchor on the bottom edge.

Again, you can also use percentages.

What's really cool is you can *also* combine relative words with pixels and percentages. Some examples:

- x: center+10 - Positions the x anchor of the widget 10 pixels to the right of the center position.
- x: center-10 - Positions the anchor 10 pixels to the left of the center.
- y: top-10% - Positions the y anchor 10% below the top edge of the slide.

5. Try to use relative & percent positioning for everything

If you can manage to use relative (top/bottom/left/middle/etc.) and percentage values for everything, then your display system will be completely resolution independent!

Remember we said that the logical size of a display in MPF can be scaled up to any size physical display. So if you build your configs for a 1024x768 display, and then a few years down the line, you install a 1600x1200 monitor, you can make one simple config change to tell MPF to scale your 1024x768 up to the 1600x1200 display. That's fine, but you won't have a display that's as crisp as it can be because the graphics card will be scaling everything.

However, if you config all your widget positioning using only relative positions and percentages, then if you get a new display in the future, you can change the native logical resolution of your display in MPF and then make full use of the full resolution. It would be like everything instantly becoming high res!

6. Widget positioning offset adjustments

Another features of widget positioning in MPF is something known as an "offset adjustment". So far we saw how anchors can be positioned in the middle or an edge of the widget. The offset adjusts let you fine-tune the position of the anchor so it can be anywhere—including off the widget altogether!

Why would you want to do that? The main reason is that sometimes the technical edge of your widget is not exactly in the position that makes the most logical sense. A good example of this is text widgets. Many fonts have bounding boxes that are a few pixels bigger than the actual rendered text. For example, the text bounding box will allow for lower case letters that hang down below the baseline, but most pinball machines only use uppercase letters. This makes it hard to align the baseline of your font because there is random space under it:

Consider the following example where you want to align the bottom of the text with the bottom of the circle. The black areas represent the visible pixels, and the gray area is the actual widget bounding box. Even though this font is small (only 5 pixels tall, uses for small text on a DMD), it still has two blank rows of pixels below every letter. This means that if you set the anchor_y: bottom on both your text and the circle, they will not actually be aligned:



What's even worst is that this font only has 1 extra row on top, so if you want to center-align it with another widget you won't get the actual center of the visible text.

Fortunately MPF has a way to deal with this in the form of anchor adjustments. There are four adjustment values you can configure for a widget:

- `adjust_top`
- `adjust_right`
- `adjust_left`
- `adjust_bottom`

All of these settings are optional. (They all default to 0.)

You might think it's weird that there are top, right, left, and bottom adjustments. Why not just have simple x and y adjustments? The reason is because having four is easiest when you're actually laying out your slides. For example, you might have a widget (like our text widget) with different amount of extra space on the top versus the bottom. So letting you specify an offset for the top and a separate offset for the bottom means that you can anchor and position that widget by either the top or the bottom and you don't have to mess with the adjusts each time. (It also means that center anchors will actually be in the visual center of the widget.) In other words, you set your adjustments once and never have to worry about them again.

For all the adjustments, positive values move the edge of the widget more towards the center (cutting off extra pixels), and negative values move it more away from the center (adding padding)

Going back to the example from before, if we add `adjust_bottom: 2`, that will move the adjustment point 2 pixels towards the middle, meaning our bottom alignment now actually aligns:



Negative values have the effect of adding padding to widgets, which can also be nice as you're aligning and distributing things.

The only other thing to know about adjustments is that they only affect the positioning of the widget. Adjustments are not cropping, and they will not "cut off" or "trim" the widget.

7. Widget positioning can be done in styles

One of the powerful features of widgets in MPF is that you can configure widget styles, which are like buckets of settings that are applied and merged into widget settings. You can put any widget settings you want in a style (and then specify the style to be applied to a widget in the style: setting in a widget config, a slide config, a show, or a widget player).

Styles can be used in several different ways. For example, you can configure a style for text widgets which has the font name, font size, and adjustments so you can simply add style: big to a widget and everything will be there.

You can also put x: and y: settings in styles and use them to position and size the widgets on different parts of your display. For example, you might have an area of the screen that always shows some kind of status message, and even though that might be used throughout your game, you might always want the same font, alignment, size, and positioning no matter what's there. So you can define a style called info_zone and then any text widget that uses that style will always show up in the right place. (You can also use styles for z-order and animations, so you can use a style to define popups and other things that you'll use over and over.)

See the How To guide on widget styles for details.

8. Putting it all together

So now you've seen all the options for positioning and placement of widgets. But how do you actually use them? Simple. Everything discussed here are just regular widget settings. So you can use them in slides:

```
slides:
  slide1:
    widgets:
      - type: text
        text: MY WIDGET
        x: left+10%
        y: top-10%
        adjust_bottom: 2
```

You can use them in *named widgets*:

```
widgets:
  my_cool_widget:
    - type: text
      text: MY WIDGET
      x: left+10%
      y: top-10%
      adjust_bottom: 2
```

You can use them in the widget player:

```
widget_player:
  some_event:
    my_widget:
      widget_settings:
        x: left+10%
        y: top-10%
        adjust_bottom: 2
```


And you can use them in shows:

```
- time: 1s
  widgets:
    my_widget:
      target: lcd
      x: top
      y: right-15.4%
```

How to animate display widgets

One of the features of MPF is that you can animate display widgets. Animating a widget means that you can change a widget's properties over time. You can pretty much change any numeric property, including size, position, opacity, etc.

When animating widgets, you specify multiple properties to change at the same time, or a sequence of changes one after the other (or both). You can also specify the duration of each step, the “easing” formula that affects the curve (acceleration/deceleration) of the change, and whether the animation is a one-time thing or a repeating loop.

You can also configure animations to start playing as soon as the widget is created, or tie steps (or series of steps) to MPF events, meaning a widget might be static, then the event “move_widget” is posted and it moves, then the event “remove_widget” is posted and it's animated away.

This How To guide will show you how to do all of that.

1. Understanding animations in MPF

MPF animations are properties of widgets. For example, here's a basic widget with no animations:

```
slides:
  slide_1:
    widgets:
      - type: text
        text: MY TEXT
        color: red
```

To add animations to a widget, you simply add an `animations:` setting to that widget, and then under there you add specific animation steps and settings. For example:

```
slides:
  slide_1:
    widgets:
      - type: text
        text: MY TEXT
        color: red
        animations:
          show_slide:           # animation trigger event
            - property: opacity # name of the widget property we're animating
              value: 1          # target value of that property for this step
              duration: .5s     # duration for this step (how long it takes to get there)
            - property: opacity # second step in the animation (starts with a hyphen)
              value: 0
```



```
duration: .5s
repeat: true           # added to the final step, tells this animation to repeat (loop)
```

In the example above, an `animations:` setting has been added to the widget. Then under there, you add the name of the event you want to use to trigger this animation to start. In this case, we use a special event called `show_slide:` which means these animations are triggered when the slide is shown on a display.

Next, notice that under the event, there are two steps (each beginning with a hyphen and a space).

There are several settings you can specify in each step. (See the config file reference for animations for details)

In this example, there are three settings for the first step:

```
- property: opacity
  value: 1
  duration: .5s
```

The **property** setting is the name of the widget's property that you want to animate. This can be almost any numerical property of the widget, including `x:`, `y:`, `opacity`, etc. (Different widget types have different types of animatable properties. For example, on text widgets you can animate the `font_size:`, on various shape widgets you can animate the `height:` and `width:`, etc.)

Pretty much the only thing you can't animate at this point is rotation (since MPF doesn't currently support widget rotation. That's a future feature we'll have to add).

2. Relative animation values

New in version 0.33.

Sometimes it is desirable to animate a value a relative amount from a widget's current value rather than specifying an absolute target value. This can be done using `relative: True`. With the `relative:` parameter set to `True`, the new target value will set by adding the `value:` parameter to the widget's current `property:` value when the animation starts. When `relative:` is set to `False`, the animation target uses the actual `value:` property value as its destination.

The following example animates a widget 50 pixels in the `x` direction over one second from its current location and then -50 pixels in the `y` direction over another second:

```
- property: x
  value: 50
  relative: True
  duration: 1s
- property: y
  value: -50
  relative: True
  duration: 1s
```

3. Animation trigger events

The animation trigger event (which is the `show_slide:` entry in the example from the previous step is the name of the MPF event you want to use to start the animation.

These are regular *MPF events* and can be anything—a shot being made, a switch hit, etc. (See the *event reference* for a full list of events.)

In most cases, however, you'll probably want to trigger an animation to start playing when the slide is created, so in addition to being able to use any MPF event, there are also a few special events (sometimes called “magic events”) that have special meaning here:

add_to_slide:

This event is triggered when a widget is added to a slide. This is useful when you're using the *widget_player* to add to new widget to an existing slide, and you want an animation to be applied to that widget as soon as it's added.

remove_from_slide:

This event is triggered when a widget is removed from a slide.

pre_show_slide:

This event is triggered when the slide this widget is part of is about to be shown. This doesn't necessarily get called when the slide is created or when the *slide_player:* event happens, because if the slide is not the highest priority slide, then the slide will be created but not shown. So this event happens right before the slide is shown.

If there's an entrance transition, this method is called BEFORE the transition starts. In other words, it means the animation will be playing as the slide transition is happening.

show_slide:

This event is triggered when the slide this widget is part of has been shown and is the current slide on the display. This doesn't necessarily get called when the slide is created or when the *slide_player:* event happens, because if the slide is not the highest priority slide, then the slide will be created but not shown. So this event happens right before the slide is shown.

If there's an entrance transition, this method is called AFTER the transition starts. In other words, it means the animation will NOT be playing as the slide transition is happening.

pre_slide_leave:

This event is triggered by the current slide that's being shown on a display is about to be replaced by another slide.

If there's an exit transition, this method is called BEFORE the transition starts. In other words, it means the animation will be playing as the slide transition is happening.

slide_leave:

This event is triggered by the current slide that's being shown on a display is has been replaced by another slide.

If there's an exit transition, this method is called AFTER the transition starts. In other words, it means the animation will be NOT playing as the slide transition is happening.

You might wonder what this is for, since what's the point of an animation if the slide is not showing? This is useful if you want to pause or reset an animation when the slide is not active. Then you can resume or restart the animation with the "pre_show_slide" or "show_slide" event when the slide is shown again.

slide_play:

This event is triggered when the slide this widget is part of is played as part of a slide_player: "play" command, either via a standalone slide player config or as a show step).

Other slide-related MPF events

In addition to the seven special-purpose animation trigger events listed above, there are three standard MPF events which are posted when slides are created, when they become active, and when they're removed. See the events reference for details on when these three events are posted.

- *slide_(slide_name)_created*
- *slide_(slide_name)_active*
- *slide_(slide_name)_removed*

4. Animating multiple properties at once

The example animation above includes two steps (one to set the opacity to 1 and the next to set it to 0). By default steps are sequential, meaning that one step completes before the next one starts. However you can add a timing: with_previous to an animation step which will make it so that step runs at the same time as the step before it. This means you can animate multiple properties at once.

For example, to make the text grow and shrink while also fading on and off:

```
slides:
  slide_1:
    widgets:
      - type: text
        text: MY TEXT
        color: red
        font_size: 50
        animations:
          show_slide:
            - property: opacity
              value: 1
              duration: .5s
            - property: font_size
              value: 100
```



```

        timing: with_previous      # makes this step run at the same time as the previous one
        duration: .5s             # specify a duration for each step, even when with_previous
-   property: opacity
    value: 0
    duration: .5s
    repeat: true
-   property: font_size
    value: 50
    duration: .5s

```

Notice that the animation in the example above has 4 steps, but steps #2 and #4 have the setting `timing: with_previous`. You can chain together as many `with_previous` steps as you want. (The default setting for one step to run after the previous one is `timing: after_previous`, but since that's the default you don't need to explicitly add it.

Also note that all 4 steps above specify `duration: .5s`. However you can make each step a different amount of time. In fact you can even make multiple `with_previous` steps different durations (though the animation won't move on to the next `after_previous` step until all the simultaneous steps are complete).

By the way, the example above is a widget that's part of a slide, but remember you can add animations to widgets anywhere a widget is defined (in the slide properties, in a show step, as part of a *named widget*, as part of a `widget_settings: override` section in the `widget_player:`, etc.)

It is also possible to animate multiple properties in a single animation step by using a list in both the `property:` and `value:` parameters (there must be the same number of items in both lists). The following example moves a widget diagonally to the coordinate (10, 20) over 5 seconds:

```

-   property: x, y
    value: 10, 20
    duration: 5s

```

5. Multi-step animations with different trigger events

So far all of the animation examples have been triggered on the `show_slide` event (which means they start animating as soon as the slide is shown).

You can create multiple event entries in the animation that cause different animations to take place when different events occur. You can mix and match these as much as you want, including mixing the "special" animation trigger events with regular MPF events.

```

slides:
  slide1:
    widgets:
      - type: text
        text: I'M GOING TO MOVE
        x: 50
        y: 50
    animations:
      move_up:
        property: y      # if there's just one animation step, we don't need the hyphen
        value: 100
      move_down:
        property: y

```



```

    value: 0
move_right:
  property: x
  value: 100
move_left:
  property: x
  value: 0
move_home:
  - property: x
    value: 50
  - property: y
    value: 50
  timing: with_previous

```

In the above example, we have five different animation events configured. These are just regular MPF events which you can use from logic blocks, shots, switch events, etc. When the event `move_up` is posted, this widget will move to the top of the display (`x: 100`), when the `move_left` event is posted, it will move to the left of the screen, etc.

If `move_home` is posted, there are two steps in the animation which both run together to move the widget back to its initial position.

Again, you can use any combination of properties and any number of steps for each event.

6. Looping and repeating animations

So far, every animation sequence we've looked at will just run through once and then stop. However, you can add `repeat: true` (or `repeat: yes`) to the last step of an animation, and that will cause that animation to loop back to the beginning and keep repeating.

Of course you can mix-and-match repeating animations with one time animations. For example:

```

slides:
  slide1:
    widgets:
      - type: text
        text: BOO!
        y: -50
        font_size: 90
    animations:
      show_slide:
        property: y
        value: 50
        duration: 500ms
      pulse_boo:
        - property: font_size
          value: 100
          duration: 250ms
        - property: font_size
          value: 90
          duration: 250ms
          repeat: true
      bye_boo:
        - property: y
          value: 100

```



```
- property: x
  value: 150
  timing: with_previous
```

In the example above, when the slide is shown (or when the widget is added if this config was in your `widgets:` section and you added it via a `widget_player: entry`), the widget will fly into the slide from the bottom (since the initial `y` value is `-50`, it will start off the screen). Then when the `pulse_boo` event is posted, the two-step animation which makes the font size bigger and smaller will start playing and repeat forever. Finally when `bye_boo` is posted, the widget will fly off the screen to the upper right.

7. Inserting a “pause”

Sometimes you might want to add a timed “pause” to an animation, where one step animates, then it pauses, then another step animates.

The easiest way to do that is just to add a step where the property value in the step is the same as whatever value that property is currently at. This is easy to do using a relative property value of `0` as shown in the following example. So you still have the step in the animation, it just isn’t doing anything since the widget’s property is already at the desired target value. For example:

```
slides:
  slide1:
    widgets:
      - type: image
        image: flying_toaster
        y: -50
    animations:
      show_slide:
        - property: y
          value: 50
          duration: 1s
        - property: y
          value: 0
          relative: True
          duration: 2s
        - property: y
          value: 200
```

In the example above, the `flying_toaster` image will move in from the bottom of the screen (to `y:50`) in 1 second, then pause for 2 seconds (since `y: 50` again), then move out of the top of the screen in 1 second.

8. Easing

You can also set “easing” values for each animation step which controls the formula that’s used to interpolate the current value to the target value over time. The default is `linear` which just does a constant motion (no acceleration/deceleration) over time. Refer to the [Easing Instructions](#) for details on how this works and descriptions of all the options.

9. Creating reusable “named” animations

Much like *named widgets*, you can also create pre-defined animations that you can easily apply to any widget. You do this by adding those animations to the `animations:` section of your config, like this:

```
animations:
  fade_in:
    property: opacity
    value: 1
    duration: 1s
  fade_out:
    property: opacity
    value: 0
    duration: 1s
```

Now you can use these animations, by name, in any widget or widget_player config where you would ordinarily define your own animations.

For example, to configure a widget to fade in (assuming the widget was initially created with opacity: 0):

```
widgets:
  hello_widget:
    - type: text
      text: HELLO
      animations:
        show_slide: fade_in
```

Again remember this can be done anywhere you configure an animation. So if you later wanted to fade that text out when the event “timer_hurry_up_complete” is posted, you can do it like this:

```
widgets:
  hello_widget:
    - type: text
      text: HELLO
      animations:
        show_slide: fade_in
        timer_hurry_up_complete: fade_out
```

10. Chaining multiple named animations together

When working with named animations, you can chain together multiple named animations for a single event by specifying them as a list, like this:

```
widgets:
  hello_widget:
    - type: text
      text: HELLO
      animations:
        some_event: anim1, anim2, anim3
```

Any animation with `timing: with_previous` in the first step will run with the previous one, meaning you can create lots of little effects and sub-animations and then combine them in reusable ways throughout your config.

You can even use the same animation over and over in a sequence to repeat something a certain number of times. For example:

```
animations:
  pulse:
    - property: opacity
      value: 0
      duration: 100ms
    - property: opacity
      value: 1
      duration: 100ms
      timing: after_previous

widgets:
  widget1:
    ...
    animations:
      flash_3x: pulse, pulse, pulse
```

In the example above, when the MPF event “flash_3x” is posted, it will cause widget1 to pulse three times.

Easing Instructions

MPF has the ability to use “easing” functions to adjust the acceleration and deceleration of motions associated with *slide transitions* and *widget animations*.

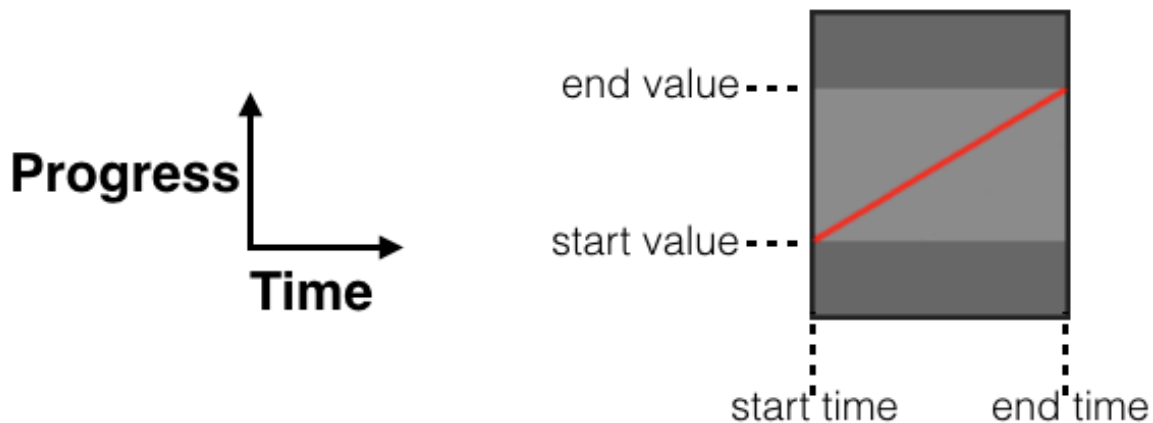
An easing function is a formula that calculates a progress value based on an input value.

Let’s look at a simple (but not realistic) example of animating a widget that moves 10 pixels in 10 seconds. With no easing function applied, it would have moved 1 pixel after 1 second, 2 pixels after 2 seconds, etc.

At first you might think this seems fine, but to the viewer it will not look natural because it will instantly start moving at full speed, and then it will stop suddenly when it gets to the end. A more natural approach would be to have it accelerate slowly at the beginning and then to decelerate as it approaches the end.

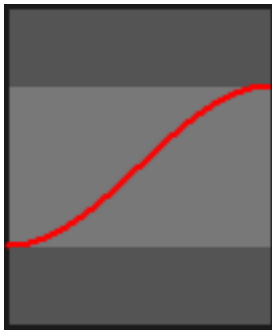
All animation and transition functions in MPF change a value over a certain amount of time. (Move 50 pixels in 2 seconds, change the opacity from 100% to 50% in 500ms, etc.)

We can illustrate this with a graph, where time is the X axis, and the value is the Y axis, like this:



The image above shows the default formula with no easing applied. (This is technically the “linear” easing function.) The value of the function is directly related to the time, and the speed of change is the same at the beginning and end.

But what if we wanted our animation to start slow and accelerate, then slow down again towards the end? For that, we could use a formula like this:



Notice that at the beginning (in the lower left corner), as you move right, the red line doesn’t change too much. Then towards the middle, the red line changes more as the transition speeds up, and then at the end (towards the upper right), the line changes more slowly.

Here’s an animated GIF which shows five different easing functions applied to animate text moving left and right.

Don’t worry about the function names. We’ll cover those in a bit.

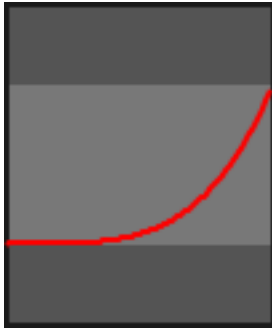
Note: If you’re viewing the PDF version of these docs, you won’t see the GIFs since they’re animated. You can view the docs online to see them.

Note that the move to the left and the move to the right are two separate animations, meaning the a single movement left or right is showing the same easing function used in both directions.

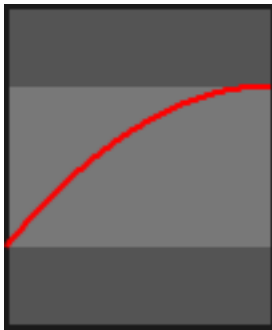
If you’re curious about the MPF config used to create this animated GIF, we’ve posted it [here](#).

You can also imagine how an easing formula would look if you wanted something to start slow, but then speed up without slowing down again. (This might be useful if you want a widget to move off

screen since it will have a gentle start and then it will shoot off and get faster and faster.) That function might look like this:



Conversely, if you have a widget coming in from off screen, you might want it to start out fast and then slow down as it approaches its final location. For that you could use what's essentially the opposite of the previous formula, like this:



The important thing to remember with these easing formulas is that the red line does NOT represent the path the moving objects take, rather, it represents how the progress of the change happens over time.

Where can you apply easing?

In MPF, these easing functions are used in two places:

- For widget animations, to affect how the progress of an animated property progresses over time.
- For some (not all) slide transitions, to affect the progress of the transition over time.

Remember when you're animating a widget, you can animate ANY numerical property. So this can include the x/y position on the display, but it can also include the size, scale, and/or the opacity (transparency).

Here's an animated GIF showing the same five easing functions applied to each text widget's opacity property (cycling them between 1 and 0):

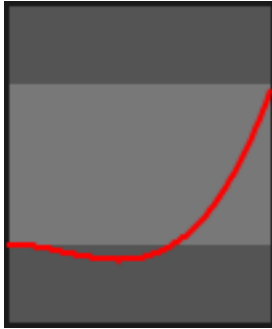
Refer to the [slide transition](#) and [widget animation](#) documentation for details on how to actually apply these easing functions. It's pretty straightforward—essentially you just add easing: <function_name> to the animation or transition property, like easing: in_out_circ.

Now let's look at the different types of easing functions MPF supports:

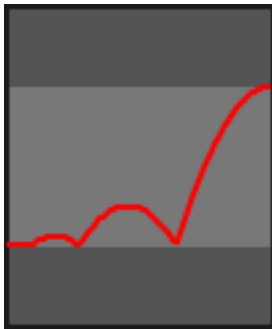
Easing “start” functions

The following functions apply an easing formula at the beginning of the time and then accelerate to the end:

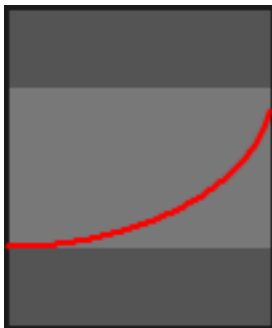
easing: in_back



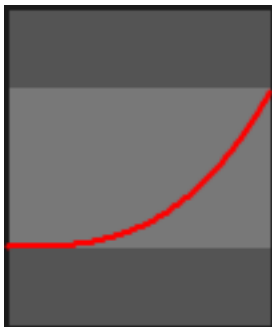
easing: in_bounce



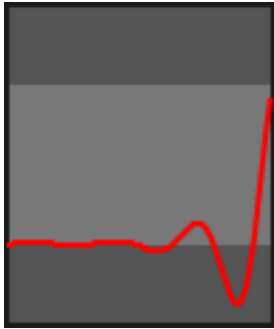
easing: in_circ



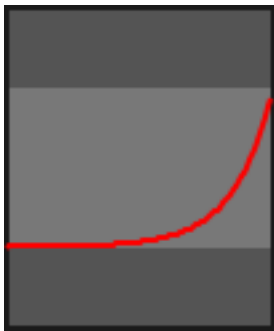
easing: in_cubic



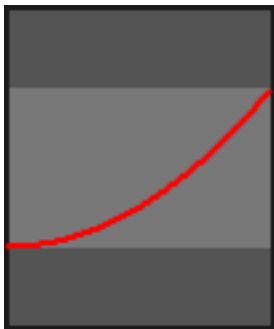
easing: in_elastic



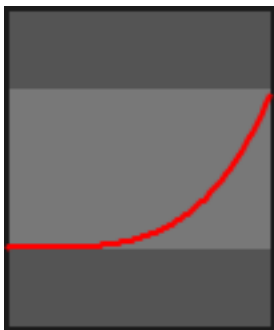
easing: in_expo



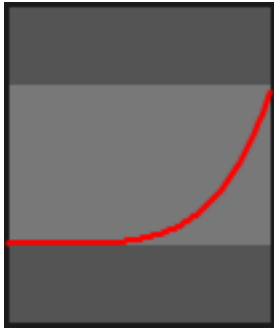
easing: in_quad



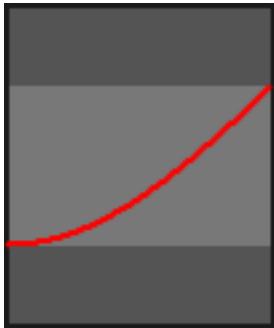
easing: in_quart



easing: in_quint



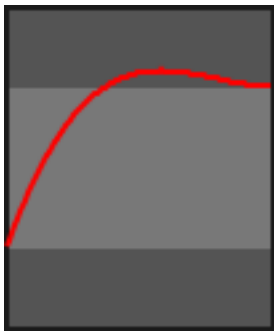
easing: in_sine



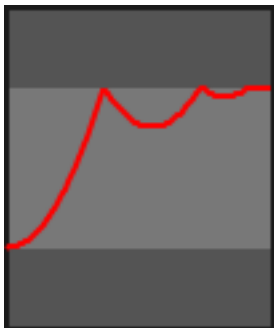
Easing “end” functions

The following functions apply an easing formula at the end of the time, meaning they start fast and then slow down towards the end:

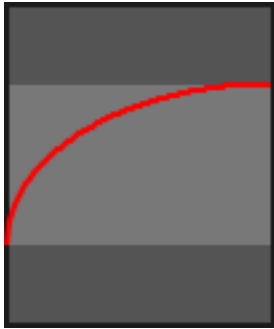
easing: out_back



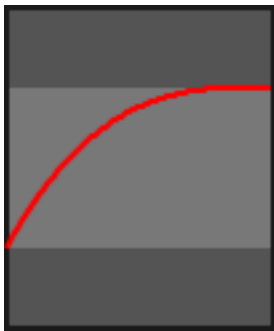
easing: out_bounce



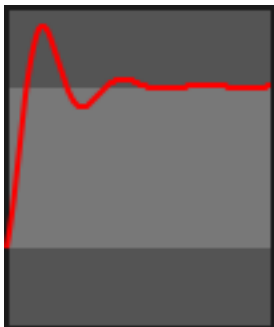
easing: out_circ



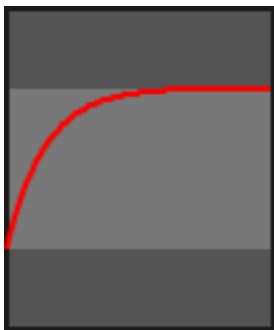
easing: out_cubic



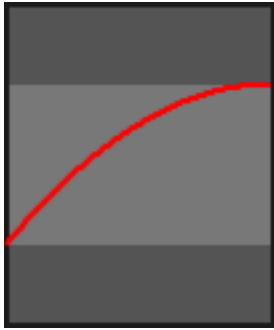
easing: out_elastic



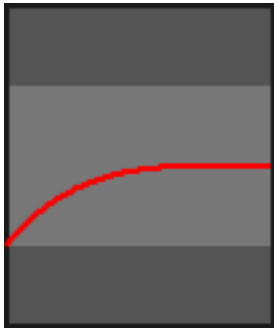
easing: out_expo



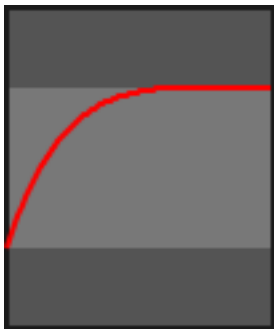
easing: out_quad



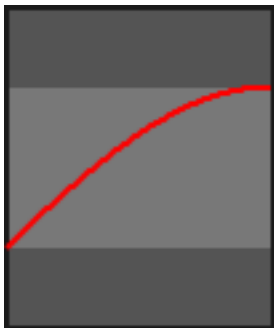
easing: out_quart



easing: out_quint



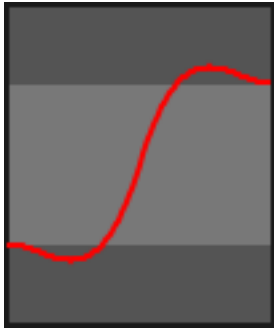
easing: out_sine



Easing both “start” and “end” functions

The following functions apply the easing to both the beginning and the end of the time, meaning they start slow, accelerate in the middle, and then slow down again at the end.

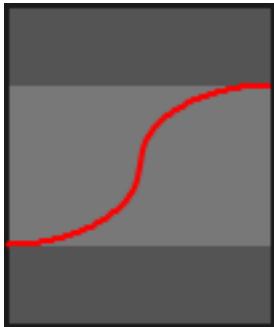
easing: in_out_back



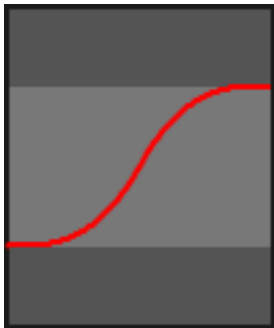
easing: in_out_bounce



easing: in_out_circ



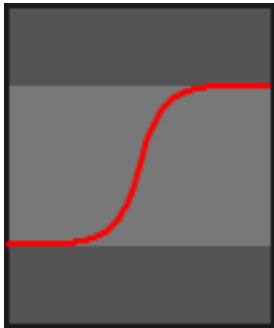
easing: in_out_cubic



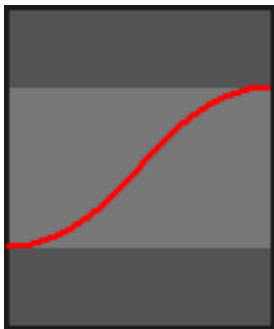
easing: in_out_elastic



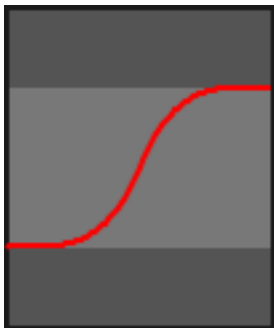
easing: in_out_expo



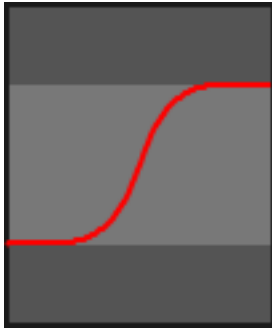
easing: in_out_quad



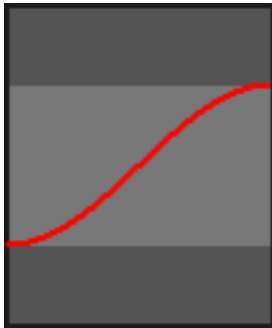
easing: in_out_quart



easing: in_out_quint



easing: in_out_sine



We'd like to give a shout out and thanks to the creators of the Kivy multimedia library (which is what the MPC MC uses) for [creating the graphs](#) we used in our easing documentation.

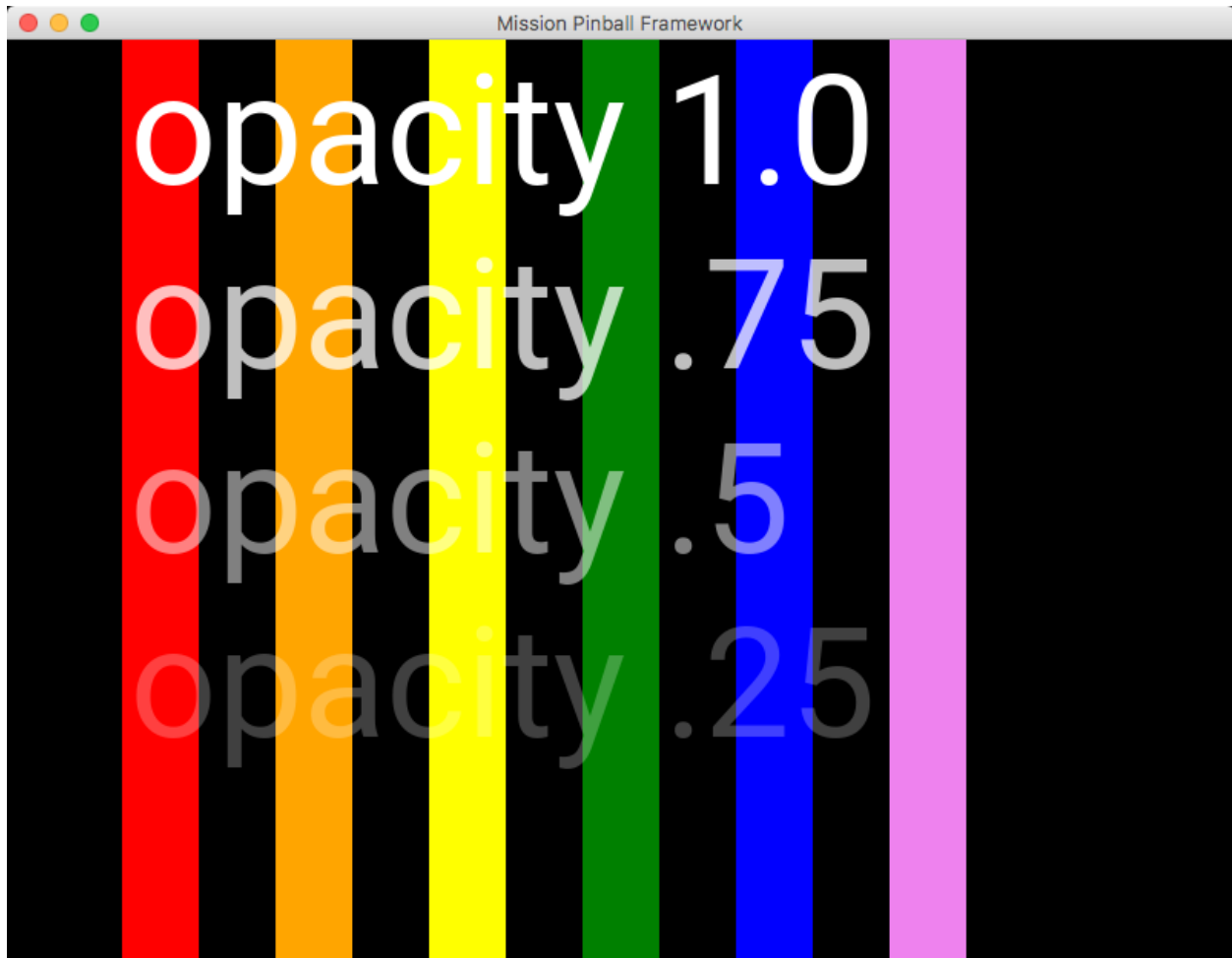
Widget Styles

todo

Widget Opacity & Transparency

All widgets in MPF can have “opacity” settings which control how transparent they are. 100% opacity is the default, where nothing would show through that widget. 0% opacity means that the widget is completely transparent and would not show up at all. 50% means it's about half-way in between, etc.

Here's an example. (This example is from the [MC Demo](#) which you can download and run to see it in action.)



Specifying opacity by opacity: setting

Every widget type has an optional setting called `opacity`: which you can use to set the opacity of that widget. This is a value from 0.0 to 1.0, with 0 meaning 0% opacity (completely transparent and not visible at all), 1.0 meaning 100% opacity (the default), 0.25 meaning 25%, etc.

Note that you can animate the `opacity` setting to cause a widget to blink or flash. This is easier than adding and removing the widget over and over, as with this method the widget stays put, it's just alternating between visible and invisible. See the [How to animate display widgets](#) guide for details.

You can apply opacity settings to all widget types, including images and videos. (The opacity setting will affect the opacity for every pixel in the image or video. If you just want an image with transparent parts, then you would use a PNG or GIF with alpha settings instead.)

Specifying opacity by color

For widget types that accept color: settings (text and the various shape widgets), you can specify a transparency level as part of the color by adding a fourth byte to the color hex value. (If your color value is only six characters, MPF automatically adds `ff` (fully opaque) to the end.

For example, regular red with 100% opacity would be:


```
color: ff0000
```

Or it would also be (this is the same as the prior example):

```
color: ff0000ff
```

If you wanted red with 50% opacity, you could enter:

```
color: ff000080
```

There's not really any difference between setting the opacity at the `color:` setting versus the `opacity:` setting. The opacity setting is nice because it's applicable to all widget types (including those without color settings), and it's animatable. But the color setting is nice because you can set the opacity and color at the same time. It really doesn't matter.

Working with Fonts

You can specify which font you want to use as a property of any of the widgets that contain text. You can use system-wide fonts that are installed on the computer running MPF as well as fonts that are in your machine's `/fonts` folder.

You specify fonts by name only (not including the extension), and MPF will first look in your machine's fonts folder, and if it doesn't find the font there, it will look in the MPF-MC's built-in fonts folder, and finally in your machine's system fonts location.

Note: The MPC MC contains a few pixel-based fonts for use on DMDs. See [How to use DMD fonts](#) for details.

For consistency of appearance across computers, we highly recommend that you put the fonts you want to use in your machine's fonts folder.

Specifying which font a particular widget uses is done via that widget's `font_name:` setting, so see either the [Text Widget](#) or [Text Input Widget](#) reference for details.

Keep in mind that all widget properties, including fonts, can be configured as part of a widget style and easily applied to new widgets with a single line.

How to use DMD fonts

MPF includes three built-in fonts which are pre-configured as widget styles which look good on DMDs. These fonts are included in the MPF-MC package. They can be used with any widget that uses fonts, including the Text and Text Input widgets.

If you don't use one of these fonts on your DMD and just show some text, here's what the results look like:

```
my_slide:
- type: text
  text: MISSION
```




Sure, it works, but it doesn't look good because the default font is a regular font that's made for a high-res display.

Instead you can use these three styles. (Of course you can use your own fonts too, but sometimes it's hard to find ones that look good on a low-res DMD.)

style: dmd_big

dmd_big is 10 pixels tall.

```
my_slide:  
- type: text  
  style: dmd_big  
  text: MISSION
```



style: dmd_med

dmd_med is 7 pixels tall.

```
my_slide:  
- type: text  
  style: dmd_med  
  text: MISSION
```

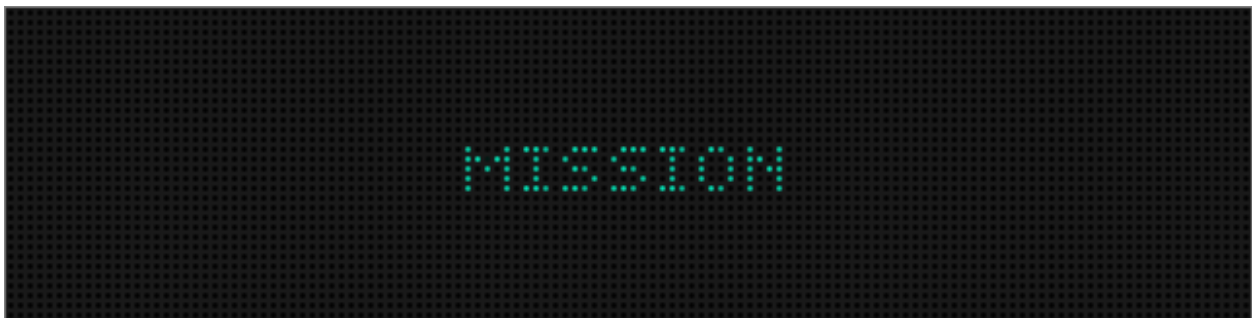



style: dmd_small

dmd_small is 5 pixels tall.

Notice that this font has a color set and we're using it with a Color DMD. All three of these fonts (like any font) can be used on a mono or color DMD.

```
my_slide:
- type: text
  style: dmd_small
  text: MISSION
  color: 00ffcc
```



How to create reusable widgets

This guide explains how you can create reusable “named” widgets that you can use again and again on multiple display slides. This saves you from having to copy-and-paste the same widget (or sets of widgets) into multiple slide configurations, it makes it easy to update and fine-tune your widget config since you only have to change it in one place, and it lets you add individual widgets to the display that will show up regardless of what slide is currently showing.

1. Understanding widgets

Before we look at how to create reusable widgets, let's look at how regular widgets work in MPF.

You probably know that you can have a `slides:` section of your config (either machine-wide or mode-specific configs), and when you define a slide, you can specify what widgets are on that slide, like this:


```
slides:
  my_slide:
    widgets:
      - type: text
        text: HELLO!
      - type: text
        x: 0
        font_size: 5
        text: YAY PINBALL
      - type: image
        image: background1
```

In the example above, the slide called *my_slide* has three widgets—two text widgets and a background image. (Remember that the “z order” or “layer” of widgets is top-to-bottom, so the *HELLO!* widget is on top, then *YAY PINBALL* is next, and they’re both on top of the *background1* image.

These three widgets are permanently attached to the slide called *my_slide*. There’s no way to reuse them on any other slides.

2. Creating reusable widgets

But what if you had a widget you wanted to use on multiple slides? For example, maybe you have a widget with some animations that comes on the display when a certain shot is made, and you want that widget to appear on any slide (whichever slide happens to be showing at that time).

The way to do that is to create a “named” widget that’s reusable. You do that in the `widgets:` section of your config. (This can be either a machine-wide or a mode config file.)

For example:

```
widgets:
  laughing_jackal:
    - type: image
      image: jackal
```

Now you have a widget defined called *laughing_jackal* that you can add to any slide. (Note that this example is simple, but any widget type with any widget settings can be defined here, including positioning, colors, animations, etc.)

The only “catch” is that the list of widget names is global across MPF. So even though you can define widgets in both the machine-wide or the mode config files, named widgets are processed when MPF starts up, so don’t use the same name twice since whichever one loads second will overwrite the first one.

3. Using your named widget

Now that you have a widget defined, how do you add it to a slide? That’s done via the “widget” config player, which means you can add a `widget_player:` section to a config file to trigger it based on an event, or you can add it via the `widgets:` section of a show step. (All the examples in this guide will be based on the `widget_player:` section of a config file, but you can use them all in show steps too. Just use them in a `widgets:` section of a show step and do not include the event name.

There are several options you can use in the widget player, depending on how you and where you want to show your widget (which display, which slide, etc.)

“Express” config

If you just want to add your widget to whichever slide is current on the default display, you can use the “express” config, like this:

```
widget_player:
  some_event: laughing_jackal
  some_other_event: another_widget
```

With the config above, when the event *some_event* is posted, the widget called *laughing_jackal* will be added to the current slide on the default display. Notice that you can add multiple entries here for different widgets and different events.

This widget is added with whatever settings you defined for it in the `widgets:` section of your config. It’s all pretty straightforward, though you might have to play with the `z:` setting (the layer) to get it to show up. (For example, if your current slide has a full size background, you’d want to configure your widget with a `z:` setting that’s a higher priority so it shows up on top of the background image.)

Adding a widget to a specific slide

If you want to add your widget to a particular slide (versus whatever slide happens to be showing at the moment), you can do so by specifying that slide name in the `widget_player:`. For example:

```
widget_player:
  some_event:          # event that will trigger this widget to show
    laughing_jackal:    # widget you want to show
      slide: my_slide
```

In the example above, when the event *some_event* is posted, the widget *laughing_jackal* will be added to the slide called *my_slide*. If *my_slide* is the current active slide on the display, you’ll see the widget appear. If that slide is not being shown, the widget will still be added, and it will be there the next time that slide is shown.

Remember you can add as many events and widgets as you want to the `widget_player:` section of your config, and you can even mix-and-match formats, like this:

```
widget_player:
  some_event:
    laughing_jackal:
      slide: my_slide
  some_other_event: another_widget
```

Adding a widget to a specific display target

Rather than specifying a particular slide to add your widget to, you can target a display or slide frame, and the widget will be added “on top” of whatever slide is currently being shown:

```
widget_player:
  some_event:
    laughing_jackal:
      target: display1
```


Remember in MPF, display targets can either be the names of a display (dmd, window, etc.), or they can be the name of a slide frame which is a widget on another slide which holds its own slides (sort of like picture-in-picture).

More details about this are in the [Widget layers, z-order, & parent frames](#) guide.

Overriding named widget settings

When you create your named widget, it contains a bunch of settings that are used to add it to a slide. (That's sort of the whole point.)

However sometimes it's useful to be able to override or add additional settings at play time. You can do this in the `widget_settings:` section of the `widget_player:` in a config file or the `widgets:` section of a show step.

For example, if you use a widget for the tilt warning like in the previous example, you'd probably want that widget to be removed after a few seconds, which you could do like this:

```
widget_player:
  tilt_warning:      # event
  tilt_warning:      # widget name
  widget_settings:   # additional settings to be added / updated
    expire: 2s
```

(Technically speaking, if you were going to show a tilt warning widget, you'd probably also want to play a sound and maybe flash all the lights on the playfield, so in your real game you're probably actually create a show to do this and then play it via the `show_player:` section of your config and include the widget in the `widgets:` section of the show, but you get the idea.)

You can also set the expiration time of a widget when you define the widget in the `widgets:` section of the config. See the config file reference for details.

You can add/update any setting for the widget (color, text, position, animations, `widget_styles`, `z` (layer), etc.)

Removing widgets

You can also use the widget player to remove named widgets from a slide that had been previous added. To do this, just add an `action: remove` setting to the widget player, like this:

```
widget_player:
  show_jackal: laughing_jackal
  hide_jackal:
    laughing_jackal:
      action: remove
```

The config above will add the *laughing_jackal* to the current slide on the default display when the event *show_jackal* is posted, and then it will remove it when the event *hide_jackal* is posted.

Creating named groups of widgets

All of the examples in this guide showed using a single widget as named widget. But you can actually define multiple widgets in a named widget (essentially meaning that your named widget is really a

named group of widgets. For example:

```
widgets:
  widget3:
    - type: text
      text: HI
      color: ff0000
      font_size: 100
    - type: text
      text: THERE
      color: 00ff66
      font_size: 100
    - type: text
      text: EVERYONE!
      color: ff00ff
      font_size: 100
```

You play, show, or hide this “widget” in the same way as every other example in this guide, except in this case, playing *widget3* will actually add all three widgets to the slide. (Again you can play with z-order / layering, and remember that each widget (even in a multi-widget group) can have its own z-order settings.

Putting it all together, these are the basics of using named widgets in MPF. The important takeaways are:

- Widget names are global, so don’t use the same name twice.
- Everything here can be done in either the `widget_player:` section of a config file or the `widgets:` section of a show step.
- All widget options are valid, including keys, animations, expiration, styles, positioning, z-ordering, colors, transparencies, padding, etc.
- When “playing” a widget, you can target a display or a slide.
- Once a widget is “played” and added to a slide, it becomes just another widget on that slide. The fact that it was put there by the widget player doesn’t matter.

Adding multiple named widgets in one event

You can also add multiple named widgets from a single event. This is nice if you want to add widgets to multiple displays or slides at the same time. For example:

```
widget_player:
  some_event:
    widget1:
      target: dmd
    widget2:
      target: lcd
```

Note that if you do this, the structure of YAML requires that you have at least one setting under each widget name, so you can just add a `target:` or `action:` add if you don’t want to change or set anything else in the widget.

Expiring (auto removing) widgets

You can use the widget player to add widgets to slides which will be removed automatically after a pre-determined amount of time. This is done via a widget's "expire" setting. There are several ways you can expire a widget:

Option 1: In the widget or slide definition

```
widgets:
  my_widget:
    type: text
    text: HELLO
    expire: 2s
```

In the example above, whenever you add that widget to a slide (via the `widget_player` or the `widgets:` section of a show), that widget will expire and disappear two seconds later.

Option 2: In the widget player

Instead of tying an expire time to a widget when you define the widget, you can specify the expiration when the widget is shown via the widget player.

Here's an example:

```
widgets:
  my_widget:
    type: text
    text: HELLO # no expiration here

widget_player:
  some_event:
    my_widget:
      widget_settings:
        expire: 2s
```

In the above example, the widget player dynamically adds the 2 second expiration time when the widget is shown after *some_event* is posted.

Option 3: Remove a widget on some event

Instead of automatically removing a widget after a pre-determined amount of time, remember you can use the widget player to remove a widget by name, which means you can use one event to show the widget and another event to remove it. For example:

```
widgets:
  my_widget:
    type: text
    text: HELLO # no expiration here

widget_player:
  some_event: my_widget
  some_other_event:
```



```
my_widget:  
  action: remove
```

In the example above, the event *some_event* will cause *my_widget* to be added to the current slide on the default display, and the event *some_other_event* will cause it to be removed.

Widget Keys

Widget keys are used to uniquely identify instances of widgets which you can later use to update or remove the widget.

Note that you can also identify widgets by name (which is almost always more straightforward). You only need to use a key if you want to put multiple instances of the same widget on the same slide, and then you need a way to identify individual ones to update or remove them.

TODO

Widget layers, z-order, & parent frames

When you have multiple widgets on a slide, you can control the layer (or z-order) of the widgets, controlling which widgets are on top of others in cases where two or more widgets overlap.

When adding a widget to an existing slide, you also have the option to add it to the “parent frame” (and not to the slide), meaning that if the slide changes, the widget will still be there.

Let’s look at how all this works.

Overlapping widgets, layers, & z-order

Any time you have two widgets that overlap, MPF must decide which widget will be drawn “on top” of the other.

At the most basic level, any time you have more than one widget listed in a config (whether it’s in a *widget_player:*, *slide_player:*, or a definition in a *slides:* or *widgets:* section), the widgets will be drawn in the order they are in the config.

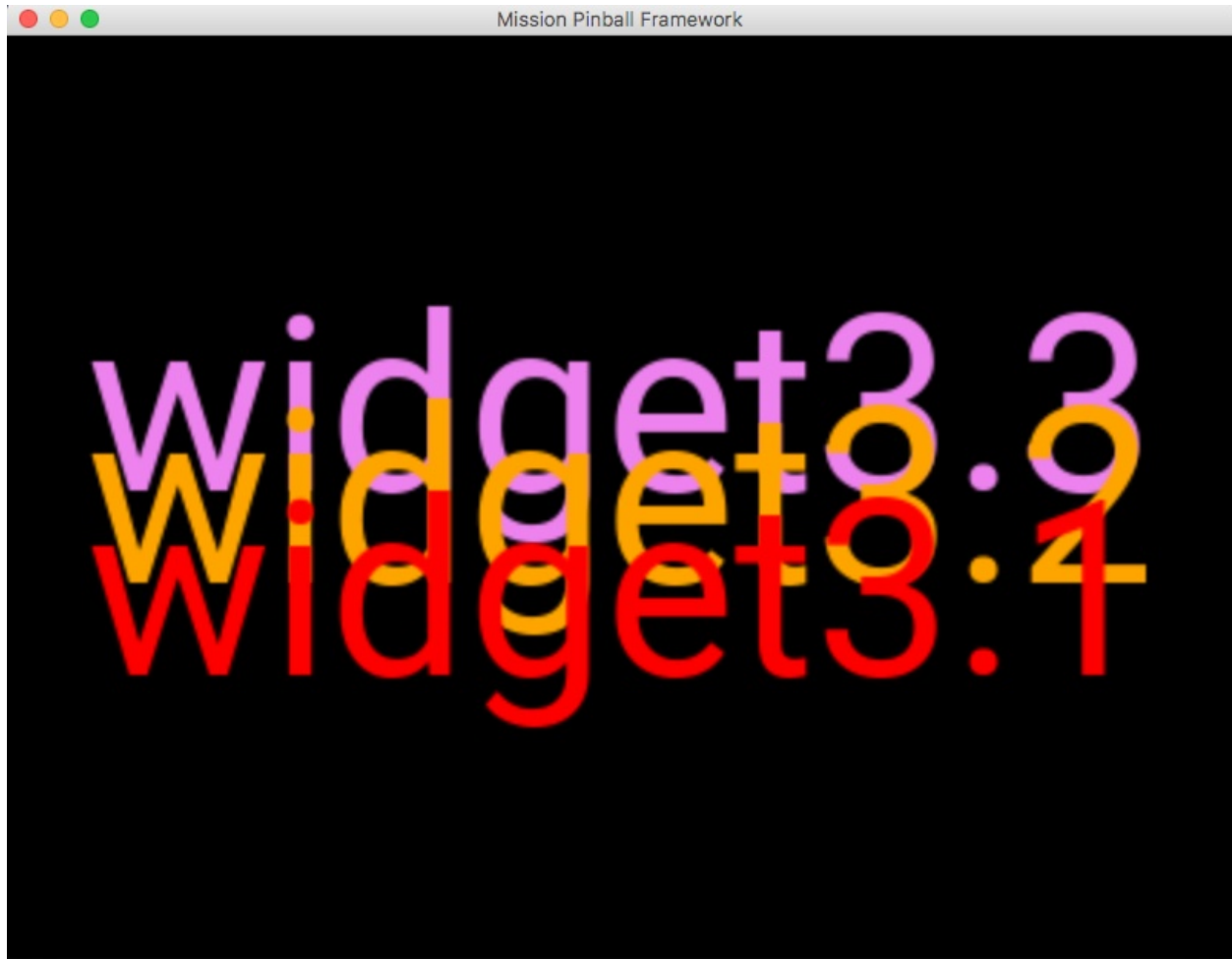
For example, here’s a slide that has *widget3.1*, then *widget3.2*, then *widget3.3*:

```
slides:  
  3_widgets:  
    - type: text  
      text: widget3.1  
      color: red  
      font_size: 80  
      y: 40%  
    - type: text  
      text: widget3.2  
      color: orange  
      font_size: 80  
      y: 50%  
    - type: text  
      text: widget3.3  
      color: violet
```



```
font_size: 80
y: 60%
```

The result is like this. Note that widget3.1 is on top of widget3.2, which is on top of widget3.3:



In this example, all three widgets are 100% opaque, but if any of them had opacity of less than 100%, then you would see the lower level widget through the higher one. See the [Widget Opacity & Transparency](#) guide for details.

You can also use the `z:` setting to manually set the relative order of how you want the widgets to overlap. Widgets with higher `z:` values will be drawn on top of those with lower values.

Here's the same example as before, but with `z:` values added:

```
slides:
  3_widgets:
    - type: text
      text: widget3.1
      color: red
      font_size: 80
      y: 40%
      z: 1
    - type: text
      text: widget3.2
```



```
color: orange
font_size: 80
y: 50%
z: 100
- type: text
  text: widget3.3
  color: violet
  font_size: 80
  y: 60%
  z: 2
```

And the results:



Note that *widget3.2* is on top since its *z:* is 100, then *widget3.3* is next with *z:* 2, and finally *widget3.1* is on the bottom with *z:* 1

Notes about z-order:

- The default *z:* value is 0, so anytime you have a widget without a *z:* setting, it's like you have *z:* 0.
- The order the widgets are listed in the config file is only used as a tie-breaker if multiple widgets have the same *z:* settings. (This is why the first example worked, since all three widgets had *z:* 0.)

- You can mix-and-match order and z: settings.
- The actual numeric z: settings don't matter. You can have 1, 2, 3 or 100, 200, 300, or 1, 20000, 1000000 or whatever you want.
- Setting z: values for widgets on a slide is only really used if you want to later use the widget player to add a widget to a slide in between certain existing widgets.
- In most slides, you will not mess with z: settings and instead use the order of the widgets in the config file to set the order they are on the slide.

Adding widgets to parent frames

When you use the `widget_player:`, it will add the widget to the current slide on the default display.

If you want to target a specific slide, you can add a `slide:` setting to your widget player with the name of the slide.

In both cases, the widget player will add the widget to a slide.

However, it's also possible to add a widget to the "frame" which holds the slides, meaning that the widget is shown "on top" of the slide rather than as part of the slide.

Why would you want to do that?

Sometimes it's useful to have a widget which "stays put" even as the underlying slides change.

One example is for tilt warnings. When the player gets a tilt warning, you might want to show the text "WARNING" for 2 seconds. However if you use the regular widget player to add this widget to the current slide, then if that slide is replaced by another slide during those 2 seconds, your tilt warning will disappear too.

Another example is the scores. Maybe you want those to show along the bottom on top of every slide? Or maybe something like the news crawl on the bottom of the *Dialed In* display?

So instead of using a `slide:` setting with your widget player, you can use the `target:` setting and enter of name of a display or a slide frame. In that case, the widget will be added there, and not to the slide, meaning your widget will ride "on top" of the slides (and even on top of any slide transitions that take place).

Widgets versus Slides: When to use each?

todo

CHAPTER 11

Segment displays

New in version 0.50.

TODO

CHAPTER 12

Sounds, Music & Audio

Note: Everything in this “Displays & Graphics” section is about default the MPF Media Controller

Since the release of MPF 0.30, audio and sound support has been provided by a brand-new custom audio library built on SDL2 and SDL_Mixer libraries. This custom library allows the MPF development team to create audio features optimized for pinball machines. The first release provides basic sound loading and playback capabilities along with some great new features like *ducking* and *sound pools*. (Sound support is part of the MPF media controller and only available if you’re using MPF-MC for your media controller).

The basic concept with audio in MPF is that you collect all your audio files (.wav or .ogg files are currently supported) and put them in the /sounds folder in your machine folder. Then in your config file you create entries for each sound which map a friendly name to the actual file on disk. You can also set a bunch of defaults for each sound, such as volume, start time, etc. Then when you want to play a sound in a game, you can refer to it by the friendly name from your configuration file. You can also add entries into your configuration file to set up sounds so they play based on certain MPF events. (For example, play the sound “laser” every time the event from a pop bumper being hit is posted.) You can also add sounds to your show files so they play in-sync with lighting and display effects.

You can think of the audio system in MPF as a sound mixing board that you control via configuration settings and events. It is divided into tracks (similar to channels on a mixer), each of which has its own properties such as name, volume and the number of sounds that may be played simultaneously. You can create up to 8 tracks in your sound system, although typically most machines will use 3 tracks (“voice”, “sfx”, and “music”). Each track has its own queue that will hold pending sounds when the track is too busy to play any additional sounds. Sounds are played on specific tracks and then the tracks are mixed together to form the final mix. The sounds themselves are objects that include many properties that control how they will be played such as what track they play on, volume, looping, priority, how long to wait in the playback queue before being discarded, *ducking*, etc.

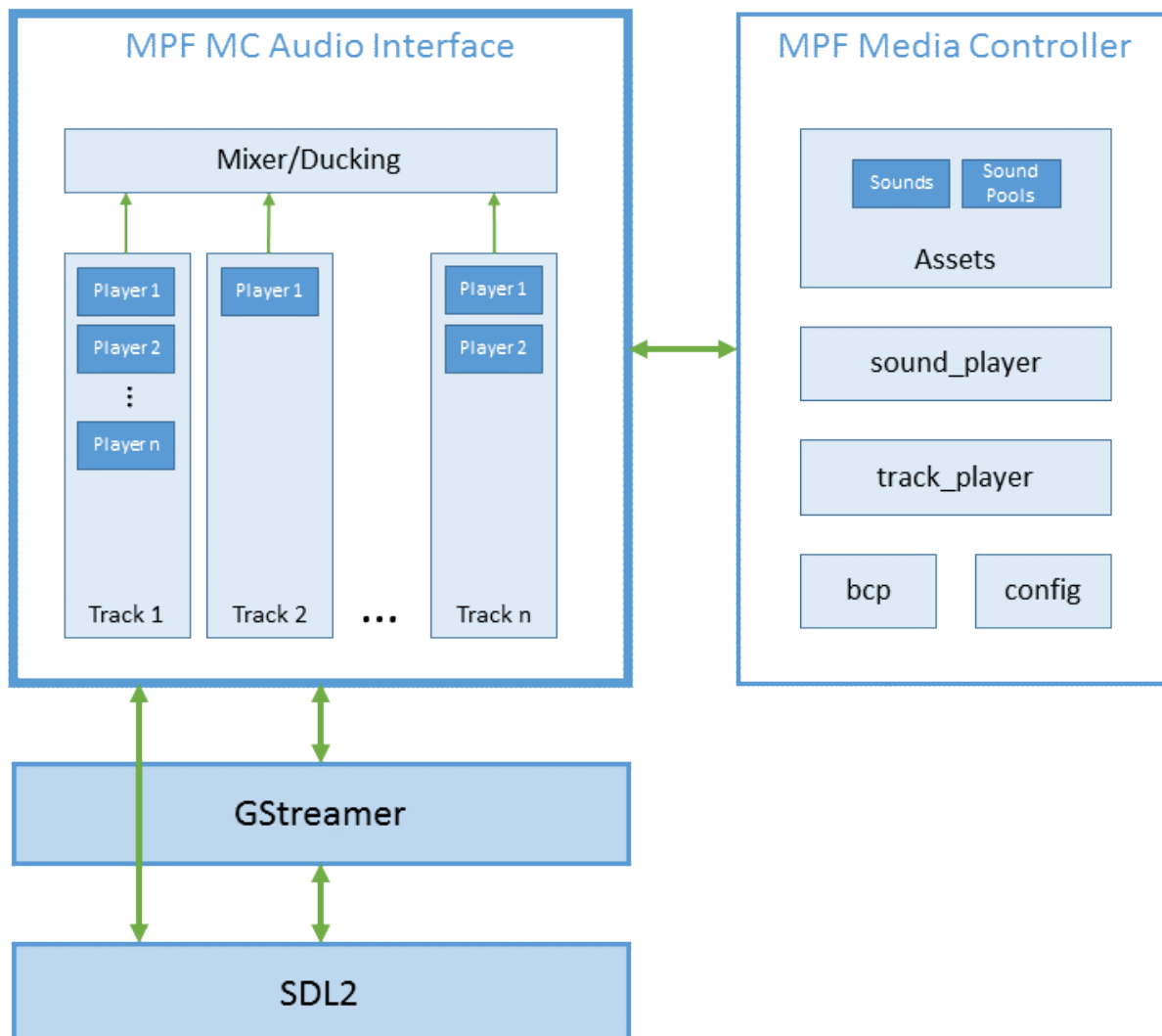
Sounds can be grouped together into a logical grouping called a sound pool. Sounds pools allow you to reference a group of sound variations as if it were a single sound. A sound pool name may be used

anywhere a sound asset name may appear. Pools can be used for random differences in a sound (such as slight variations of a slingshot sound) or for an ordered sequence of sounds that will repeat. Another common use for sound pools is to play a random callout from a defined list when triggered.

You configure your sound system (including tracks) in the *sound_system:* section of your machine configuration file. You add settings for individual sound files in the *sounds:* section and you can configure sounds to automatically play when selected MPF events are posted in the *sound_player:* section. Sound pools are specified in the *sound_pools:* section. Tracks can be controlled when selected MPF events are posted in the *track_player:* section.

MPF Sound & Audio Technical Overview

The MPF MC Audio Interface is a custom audio Python extension library with features designed to support common pinball sound requirements. It is written on top of the SDL2, SDL_Mixer, and GStreamer libraries that are installed with Kivy which is required to run the MPF MC software (no additional installs necessary for the audio library).



The SDL2 library (<https://www.libsdl.org/>) is responsible for all low-level communications with the system audio hardware. The user selects the basic audio interface settings: sample rate, output channels, and buffer size (defaults are provided). These settings are used to initialize the SDL2 library which then negotiates with the system audio hardware to create a connection that is as close to the desired settings as possible. The SDL2 library is responsible for creating the main audio thread and calling the main audio callback function at a fast enough rate to provide audio buffers to the hardware without any gaps in playback. It also provides the thread synchronization and protection utilized in the audio library through its mutex-related functions. The audio library also uses the SDL2 audio format conversion functions to convert between various low-level audio formats to communicate with the system sound hardware.

SDL_Mixer (https://www.libsdl.org/projects/SDL_mixer/) is an add-on library for SDL2 that provides basic audio mixing, sound loading and playback, and sound streaming capabilities. The MPF MC audio interface does not use the mixing features of SDL_Mixer. Instead, it only utilizes the sound file loading functions of the library.

GStreamer (<https://gstreamer.freedesktop.org/>) is an open source, cross-platform pipeline-based multimedia framework that links together a wide variety of media-handling components (including simple audio playback, audio and video playback, recording, streaming and editing) to complete complex workflows. The MPF MC audio interface uses GStreamer for all its sound file loading functions and real-time audio streaming. All audio is fed into SDL2 for final output.

The audio interface is divided into tracks, which are analogous to channels on an audio mixer. Each track can play up to 32 sounds simultaneously (the limit for each track is configurable) and the output for each track is mixed together and fed to the SDL_Mixer track via the custom music player function. All of the sound generation and mixing functions are C functions (written in Cython) that run in the SDL2 audio thread.

It is important to understand the threading models of both SDL2 and Python to avoid common threading problems. Python supports multiple threads, however it uses a mechanism called the “global interpreter lock” (GIL) to ensure that only one thread runs in the Python interpreter at once. This simplifies many low-level details. SDL2 creates its own audio thread in which to receive and process audio data and send it to the audio hardware. As this audio thread is not a Python thread, it does not interact with the GIL and therefore is unable to access any Python objects within its context. This means that only C types and data structures may be utilized in the SDL2 audio callback function; no Python objects can be used. Because the MPF MC is a Python application, a Python extension library is the only choice in which to use the GStreamer, SDL_Mixer and SDL2 libraries. Since the extension library utilizes both Python and C objects, the GIL needs to be managed in the audio library along with thread protection to avoid race conditions and deadlocks. These design constraints led to the choice of using Cython (<http://cython.org/>) as the language to implement the MPF MC audio library. Cython is a superset of the Python language that additionally supports calling C functions and using C types, an ideal choice for wrapping external C libraries and using them in a Python application.

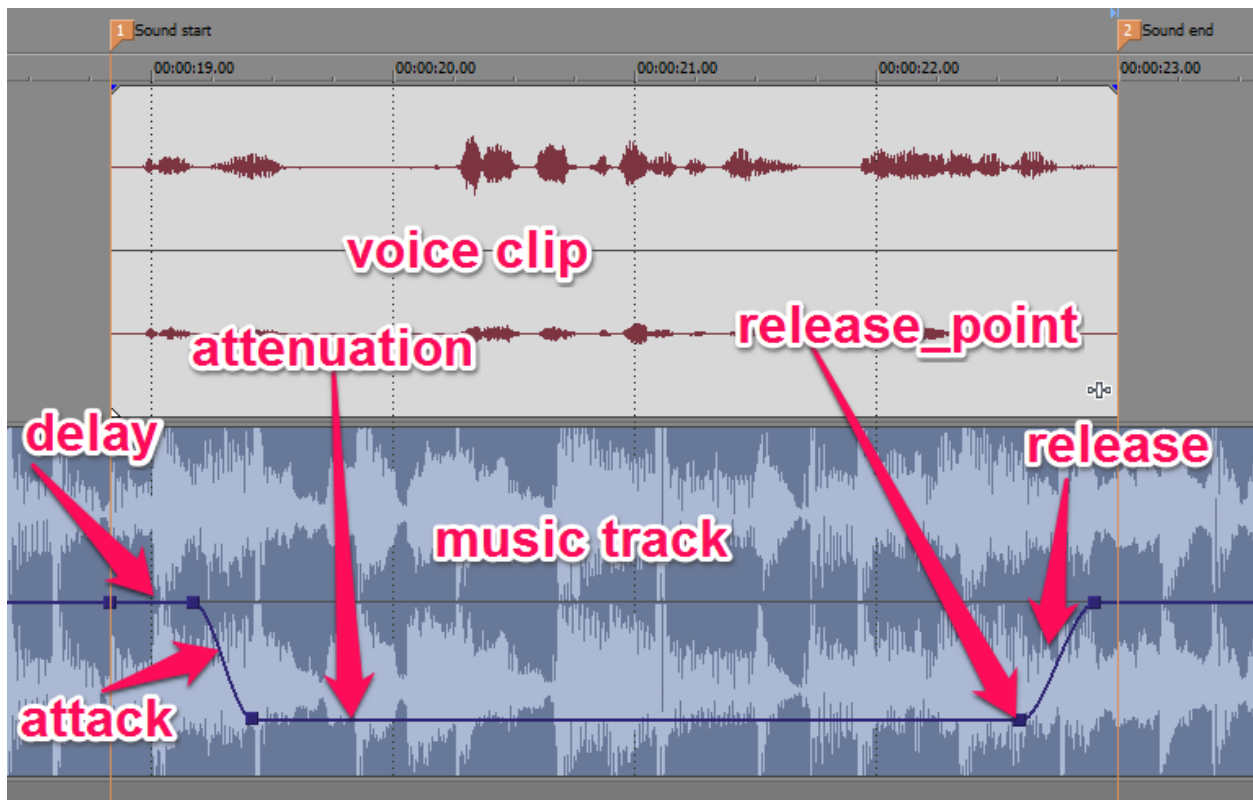
Sounds are MPF assets and are created by the MPF asset loader. The actual sound loading code is contained in the audio library and is performed by SDL_Mixer and GStreamer. A Python container object wraps the C object returned by the loading process. This wrapper allows the sound data to be managed by a Python object. The audio library extracts the C object when necessary and passes it to the audio thread where it can be used to generate audio.

The *sound_player*: enables MPF events to trigger sound actions, such as play, stop, and stop looping. It is a *config_player* and runs as a plug-in in MPF and also creates event handlers in MPF MC. The audio library also generates MPF events for various sound events (sound played, stopped, looping, etc.) and sends them to MPF via BCP.

Ducking

Ducking is an audio effect that lowers the level of one audio signal based upon the level of another audio signal (one sound “ducks” out of the way of another). It is used to allow particular sounds to be heard more clearly when there is other audio playing at the same time. In the context of a pinball machine, a common use of ducking is to lower the volume of the background music while an important callout is played (such as “Extra Ball!”) and then return the volume when the callout is finished. When done professionally, you should not really be able to notice that the music volume is being lowered, but you’ll be able to hear the callout prominently.

By default ducking is not enabled for any sounds in MPF. Ducking settings can be optionally set for each sound asset in the machine. To best illustrate ducking and its parameters, here is a diagram:



The voice clip in the top track of the diagram illustrates a callout that we wish to add ducking settings to. The bottom track is playing music. The following parameters control the ducking behavior of the voice clip:

- **target** - The track name to apply the ducking to when the sound is played. In the example above the *music* track is the target.
- **delay** - The duration to delay after the sound starts playing before ducking starts. This value may be specified as a time string or a number of samples.
- **attack** - The duration of the period over which the ducking starts until it reaches its maximum attenuation (attack stage). This value may be specified as a time string or a number of samples.
- **attenuation** - The attenuation (gain) to apply to the target track while ducking. This controls how quiet to make the target track while the sound is playing.
- **release_point** - The point relative to the end of the sound at which to start the returning the

attenuation back to normal (release stage). This value may be specified as a time string or a number of samples. A value of 0.5 seconds means to begin to release the ducking 0.5 seconds prior to the end of the sound.

- **release** - The duration of the period over which the ducking goes from its maximum attenuation until the ducking ends (release stage). This value may be specified as a time string or a number of samples.

Ducking settings are specified for each desired sound in the [sounds:](#) section of the configuration files. It often takes some trial and error to get the ducking parameters set just right for each sound.

How to setup sound for your machine

This guide explains the basic steps to setup sound for your machine. Sound support is part of the MPF media controller and only available if you're using MPF-MC for your media controller. Please ensure your system is properly setup to play sound (drivers are installed and configured) before proceeding with this guide.

1. Configuring the *sound_system*

The first step in the process of setting up sound for your machine is to setup the `sound_system:` section of your machine configuration file (see [sound_system:](#) for more detailed information). Generally you can just use the default values for the settings in the section. However, you do need to define the tracks the sound system will use. Tracks can be thought of as channels on an audio mixer with their own volume and other settings. The example below shows a typical pinball machine sound setup with three tracks: *music*, *voice*, and *sfx*. The `simultaneous_sounds:` setting controls how many sounds may be played at the same time on each track. It is recommended that you only allow one music and one voice clip to be played at a time and that many sound effects (*sfx*) can be played simultaneously so that is what we have configured in the example below.

Example:

```
sound_system:
  master_volume: 0.75
  tracks:
    music:
      simultaneous_sounds: 1
      volume: 0.5
    voice:
      simultaneous_sounds: 1
      volume: 0.7
    sfx:
      simultaneous_sounds: 8
      volume: 0.4
```

2. Configuring your sound asset folders

The next step is to configure your sound asset folders. First you will need to create a folder named `sounds` directly under your machine folder. The recommended way to organize your sound files is to create sub-folders for each track in the `sounds` folder (`music`, `sfx`, and `voice`). If you are going to be

using a lot of sounds you can create as many sub-folders beneath each track folder as you like. It can help you stay organized and be able to locate your sounds.

File system directory structure example:

```
machine_folder
  sounds
    music
    sfx
    voice
```

Now that our sound asset folders have been created, it's time to let MPF know where to look for sound files when it starts and what basic settings to apply to each sound it finds. This is done by adding a `sounds:` section to the `assets:` section in our machine configuration file. The example below illustrates what this should look like in your machine configuration file. The `default:` setting contains the default settings that should be applied to all sound assets. In this example below, `load:` should be assigned a value of `on_demand` for all sound assets. Next we enter a setting for each sub-folder located in our `sounds` directory and specify the settings we want applied to each sound asset found in those sub-folders. In our case we have created sub-directories for each track and want the sounds contained in them to play on their respective tracks (*music*, *sfx*, and *voice*) so we set the `track:` setting accordingly.

`assets:` section in machine configuration file:

```
assets:
  sounds:
    default:
      load: on_demand
    music:
      track: music
    sfx:
      track: sfx
    voice:
      track: voice
```

When your machine launches, the asset manager will now search for supported audio files in the specified directories and assign the proper settings to each file it finds. We're well on our way to actually hearing some sound!

3. Put some sounds in your sound folders

You probably don't need much assistance with this obvious step, but let's go through the process anyway just in case. As of version 0.33, MPF supports 16-bit .wav (Wave), .ogg (Ogg Vorbis), and .flac (FLAC) audio files (we hope to add other formats in future releases such as .mp3). Locate some supported audio files and place them in the appropriate track folders that you created in the previous step (a good site to find free public domain sounds is www.freesound.org). Put all music files in the music folder, voice callouts in the voice folder, and all other sound effects in the sfx folder.

4. Additional configuration for selected sounds

Now when you start your machine you will have some sounds available (assuming you placed some supported sound files in your folder during the last step) and they will all have some very basic default

settings. It is very likely that you won't be happy with the default settings for all of your sounds so let's create some more tailored settings for a few of them.

Renaming some sounds

Your sounds now all have names based on their file names (without the extensions), and by default that is how they must be referenced in your config files. Perhaps some of your file names are either a bit cryptic or contain additional text that you'd like to shorten. One option is to simply rename any files you'd like in the operating system. Another option is to setup some configuration options in your config files to reference the sound file by a different name which is what we will do next.

I downloaded a triangle sound from www.freesound.org that has an undesirable filename: 22783__franciscopadilla__80-mute-triangle.wav. I would rather just refer to it in my config files as triangle and not 22783__franciscopadilla__80-mute-triangle (which is what it will be by default). In my sounds: section of my machine configuration file (see [sounds:](#) in the documentation for more details) I can put the following text:

```
sounds:
  triangle:
    file: 22783__franciscopadilla__80-mute-triangle.wav
```

That simple configuration change will allow the sound as to be referred to as triangle wherever you refer to that sound in other configuration locations. *Note:* be sure to include the complete file name, including the extension when using the file: setting.

Setting the volume of a sound

A very common adjustment to make is to set the volume for each and every sound you load in your machine. This allows you to balance out sounds from various sources rather than trying to adjust the levels in each sound file using audio editing software. Building on the example above, let's set the volume of the *triangle* sound in our config file:

```
sounds:
  triangle:
    file: 22783__franciscopadilla__80-mute-triangle.wav
    volume: 0.85
```

volume: controls the volume of the sound and works in conjunction with the track volume and the master volume. Volume can either be entered as a number between 0.0 and 1.0 or as a decibel level (see [Instructions for entering gain values](#)) for more information). You will probably have to spend some time adjusting the volumes of many sounds in your machine to get everything to sound just the way you want it.

Note: If you hear distortion in your sounds when they are played back in a mix, be sure to try lowering the volume as you may be experiencing clipping.

Other sound settings

There are many other settings you may wish to change for some sounds in your machine.

- How do you cause your sound to loop 3 times every time it is played? Add loops: 3 to the config section for your sound. How do you loop a sound indefinitely? Add loops: -1.

- How do you adjust the which sounds can preempt other sounds and how long a sound may wait to be played before it is discarded? Use the `priority:` and `max_queue_time:` settings.
- How do you send events to MPF when a sound begins or finished playing? Use the `events_when_played:` and `events_when_stopped:` settings.
- What about ducking? Just what is it anyway? Learn about [ducking](#) in the documentation.

The documentation for the [sounds:](#) configuration section contains further information about all these settings.

Example sounds: configuration demonstrating most common settings:

```
sounds:
  triangle:
    file: 22783__franciscopadilla__80-mute-triangle.wav
    volume: 0.85
    max_queue_time: 0
  laser:
    volume: 0.5
    loops: 3
    max_queue_time: 0
  extra_ball:
    file: extra_ball_12753.wav
    events_when_started: extra_ball_callout_started
    events_when_stopped: extra_ball_callout_finished
    volume: 0.8
    priority: 50
    max_queue_time: None
    ducking:
      target: music
      delay: 0
      attack: 0.3 sec
      attenuation: 0.45
      release_point: 2.0 sec
      release: 1.0 sec
  slingshot_01:
    volume: 0.5
    max_queue_time: 0
  song_01:
    volume: 1.0
    priority: 100
```

5. Hooking up an MPF event to play a sound

Now that your sounds have been setup and are available in your machine, the next step is to configure them to be played. The sound player was designed to do just this (associate a sound action, such as play or stop, with an MPF event). The sound player can be configured in either the machine configuration file, a mode configuration file, or even in a show step (or in all of them). To keep things simple here, let's configure the sound player in the machine configuration file.

The scenario in this example is we want our song from the previous example (`song_01`) to play infinitely when the *attract* mode starts and stop when the *attract* mode stops. Create the following entries in the `sound_player:` section of the machine config file:


```
sound_player:
  mode_attract_started:
    song_01:
      action: play
      loops: -1
  mode_attract_stopped:
    song_01:
      action: stop
```

That's it. The `song_01` sound will be played on the music track whenever *attract* mode is started and will stop whenever *attract* mode is stopped. The `mode_attract_started` section refers to a standard MPF event that is sent whenever a mode named *attract* is started and `mode_attract_stopped` is a standard MPF event that is sent whenever a mode named *attract* is stopped. For more information, see the [sound_player](#) documentation.

Finished

Congratulations! You have completed your the basic sound system setup and should have some simple audio playing in your machine.

References

- [Sound & Audio](#)
- [Ducking](#)
- [sound_system](#):
- [sounds](#):
- [sound_player](#):
- [Instructions for entering gain values](#)

Sound & Audio Tips & Tricks

This page contains a collection of miscellaneous tips and tricks when working with the sound & audio features in MPF.

Review `max_queue_time` Settings for Long Sounds/Music

The `max_queue_time` settings for sounds can lead to some unexpected behavior, especially for longer sounds (like music). This setting specifies the maximum time a sound can be queued before it's played. On a track that supports only a single sound at a time (like a typical music track), playing a sound with a priority that is less than or equal to the currently playing sound will have to wait until the current sound is finished (it will be added to the queue). That may be acceptable to you, but you may also be surprised when you hear the sound a minute or two later.

It is suggested you review all your `max_queue_time` settings to make sure they make sense for the sound and situation in which they will be played. The default setting of `None` means the sound will eventually be played, no matter how long the wait in the queue is. A value of `0` specifies the sound will

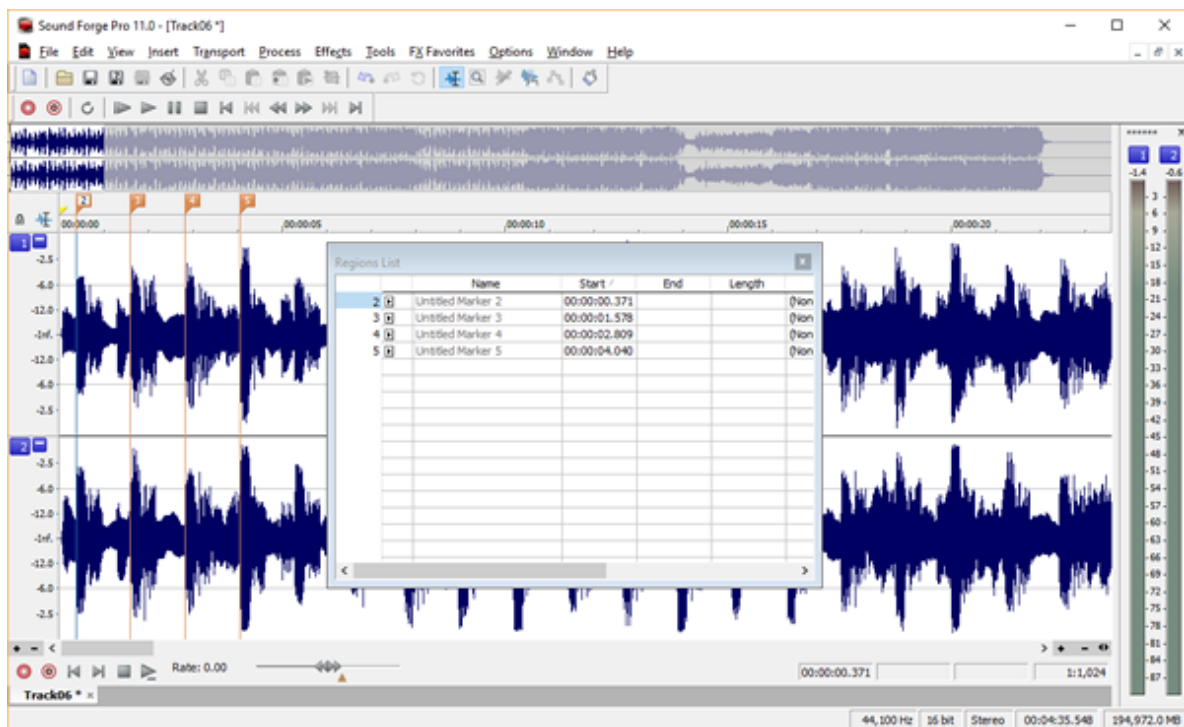
be immediately discarded if the track is already busy playing its maximum number of sounds. A value of 2 secs specifies the sound will wait in the queue for 2 seconds to be played before being discarded. Sound effects for things like slingshots and pop bumpers probably don't make much sense if they are played more than 250 milliseconds after they are hit so setting `max_queue_time` to a value between 0 and 250 ms is recommended. On the other hand, an extra ball callout is probably fine to play a few seconds after the ball is earned. Go through your sounds and consider how to set this setting for each one.

For more information, see the [sounds](#) documentation.

Synchronizing Sound With an LED Show

The key to synchronizing an LED show with a music track is to determine at what times in the sound file you want events (such as LED color changes) to occur. There are many ways to do this, but here are a few suggestions:

- Use your favorite sound or editing software to open your music track and place markers in all the locations where you want LED changes to occur. This may take some trial and error and listening to portions of your music over and over again until you get it right. Once your markers are in place, export them to a text file (if your software supports it), or write down the times of each marker. Use the times as step times in your show and assign the LED settings you want in each step. This is a bit of a tedious process, but should give you nice synchronization when the show is played at the same time as the music track (you can even put the sound play action in the first step of your show). I work on a PC and use Sony Sound Forge for sound editing, but there are many good editors available on every platform that support inserting markers. Here is a screenshot of the process in the editor I use:



This feature is also available in [Audacity](#) (free open-source cross-platform sound editing software) and many video editing packages.

- As an alternative, you can determine the tempo of your song in beats per minute (BPM) and from that number calculate the time for each beat. Once you have the time for each beat, you can use it to calculate various show step times (assuming you want LED changes to occur on the beat). There are some tools out there that will calculate the BPM of your song for you, but are not always very accurate depending upon the content of your song.

For more information on creating shows for your LED, see the [Shows](#) documentation

Pausing Background Music While a Video is Playing

New in version 0.32.

With the addition of the new [track_player](#) config player in 0.32, it is now possible to control audio tracks using MPF events. One common use of this new functionality is to pause your music track while you play a video and resume the music when the video is finished playing.

The basic concept is to add an event to the video that is triggered when the video is played and one when the video is stopped. Those events are then added to the `track_player` section of your config file:

```
track_player:
  my_video_is_playing:
    music:
      action: pause
      fade: 1 sec
  my_video_has_stopped:
    music:
      action: play
      fade: 1 sec
```

That's all there is to it. Now whenever the `my_video_is_playing` MPF event is posted, the music track will be paused. It will be resumed when the `my_video_has_stopped` MPF event is posted.

How to play a sound with variations

One of the ways to make your machine more professional is to use different variations of sounds in your machine. This will add variety and make your audio less predictable and more “alive”. This guide explains how to play a sound with multiple variations in your machine. Sound support is part of the MPF media controller and only available if you’re using MPF-MC for your media controller. This guide assumes you have already configured your sound system for your machine and are familiar with the basic sound setup concepts. If not, please start with the [Setting up sound for your machine](#) guide first.

1. An brief introduction to sound pools

Sound pools allow you to group multiple sounds together and treat the pool as a single sound. Each time a sound pool is played, it selects a sound from its group of sounds. The selection can be configured to be random or in a particular sequence. For more complete information, please read the [sound_pools](#) documentation.

Although sound pools can be used to play a random music track or random callout when an event occurs, in this guide we will be using a sound pool to play variations of a sound when a slingshot is hit.

2. Add a sound and some variations

Before we can create our sound pool, we first need to configure the individual sounds that will make up our pool. We've decided we want to have a small ding (like a triangle hit) play whenever the slingshot is hit. Let's start by adding our basic sound to our sound assets. The hardest part of this process is to either generate or find the sound you want (we won't go into that process here). Once you have your sound file, put it in the appropriate sound asset folder. I found a simple triangle sound on www.freesound.org that we'll use here, *13147_looppool_triangle1.wav*. Place the file in your sound effects track folder (<machine_folder>/sounds/sfx). Now we'll add it to your machine configuration file, but give it an easier name to remember (*triangle_01*) using the `file:` setting (or you could simply rename the file to *triangle_01.wav* and omit the `file:` setting):

```
sounds:
  triangle_01:
    file: 13147__looppool__triangle1.wav
    volume: 0.7
```

Now add a few variations of the sound. I used my favorite sound editor to slightly adjust the pitch and frequency content of the triangle sound file, creating three variations. You can also just find some other similar sounds on the internet. After you have your variations, place them in the same directory as your first sound file. We are now ready to add them to the `sounds:` section in the machine configuration file (I named the sound variations *triangle_02*, *triangle_03*, and *triangle_04*):

```
sounds:
  triangle_01:
    file: 13147__looppool__triangle1.wav
    volume: 0.7
  triangle_02:
    volume: 0.7
  triangle_03:
    volume: 0.7
  triangle_04:
    volume: 0.7
```

3. Configure the sound pool

We now have 4 variations of the same basic triangle sound. It's time to put them all into a single sound pool object so we can treat them as a single sound. To do so, we need to add a `sound_pools:` section to our machine configuration file as follows:

```
sound_pools:
  triangle:
    type: random
    sounds:
      - triangle_01
      - triangle_02
      - triangle_03
      - triangle_04
```

We now have a sound pool asset called *triangle* that acts just like a sound asset, except that each time *triangle* is played, one of the 4 sound variations contained in the sound pool will randomly be selected to be played. Want to add more variations or take one out? It's just as simple as modifying the list of sounds in the sound pool.

This is great, but let's adjust the sound pool settings a bit to fine tune its behavior. We really want the main sound (`triangle_01`) to be played more often than the other sounds. How can we make that happen? It's very easy to do. We can add weights to each sound in the pool that specify the probability of each sound being selected. Let's look at our `sound_pools:` section again:

```
sound_pools:
  triangle:
    type: random
    sounds:
      - triangle_01|5
      - triangle_02|2
      - triangle_03|2
      - triangle_04|1
```

Notice we've added a pipe character (`|`) to the end of each sound followed by a numeric value. These values assign a relative weight to each sound that will be used in the random selection process. `triangle_01` has a relative weight of 5 out of a total weighting of 10 (simply add all the weight values), therefore its probability of being selected is 50%. The `|1` appended to `triangle_04` is unnecessary because a relative weight of 1 is the default value for all sounds in the pool that do not have explicit weight values assigned.

That's it. Your sound pool has been configured to play a weighted random variation of our triangle sound every time the triangle sound pool is played. For additional sound pool setting options, take a look at the [sound_pools](#) documentation.

4. Configuring the sound player

We have our sounds and sound pool configured. To trigger the sounds with MPF events, the sound player can be used. The sound player was covered in the previous tutorial and will not be covered again here. You can also read the [sound_player](#) documentation.

CHAPTER 13

Shows

In MPF, *shows* are containers that hold steps of instructions for things that can be “played” in a certain order with specific timings.

You can do almost anything in a step in a show, including setting the color of LEDs, playing sounds, showing slides on the display, posting events, firing drivers, etc.

You’re going to use shows a lot.

Note: Prior to MPF 0.30, “light shows” and “display shows” were two independent things. In MPF 0.30+, shows are now universal. There’s only one type of show, and it can be used to do anything.

Shows are controlled and run by the MPF game engine, and if a show contains actions in a step for the media controller, such as display or sound actions, then those actions are sent via BCP to the media controller when that step is played.

Shows are configured via the YAML formatting just like config files. You can add the definitions for simple shows into your config files directly, or you can create standalone shows files that you store in your machine’s ‘shows’ folder.

At this time, it’s only possible to create and edit shows by editing the YAML files by hand. At some point we’ll create a graphical show editor, but that’s probably a ways away. (Unless anyone wants to volunteer to write it?)

Read on for more info on how shows work:

Show configuration format

Shows are defined via nested key/value pairs in YAML files.

A show contains multiple steps, and each step contains a time (for when that step should run) and instructions (for what actions should happen in that step).

Here is a very simple show with two steps. The first step sets the color of *led1* to *red*, then one second later, it turns *led1* off again. Then after another second, the show is over. (Most likely you'd configure a show like this to *loop*, meaning this should could be used to flash *led1* on and off.)

```
- time: 0
  leds:
    led1: red
- time: +1
  leds:
    led1: off
- time: +1
```

There are *lots of different actions you can configure in a show step* (LEDs, lights, sounds, coils, display slides, etc.), but for now we'll just use this very simple show as an example.

Defining steps

Shows are configured via YAML-like format, just like config files.

In the example show above, note that each *step* in the show starts with a key/value pair that's separated with a dash, then a space. So you could say that the example show above has three steps:

Step 1:

```
- time: 0
  leds:
    led1: red
```

Step 2:

```
- time: +1
  leds:
    led1: off
```

Step 3:

```
- time: + 1
```

Important: YAML formatting can be tricky. It's important that you include a space between the dash and the key name. `-time: 0` will not work and give you an error (since there is no space between `-` and `time`). Also, make sure the individual setting names are all aligned vertically. (In the example above, *time:* and *leds:*) are left-aligned.

Setting step time

The `time:` setting in each step represents the time when that step *starts*. The first step will always be `time: 0`

If you just enter a number for the *time*, that number represents seconds. However, you can enter the time in *standard MPF time format*, which could be *ms*, *secs*, etc. The following are all valid *time* entries:

- `time: 1` (1 second)
- `time: 1.0` (1 second)
- `time: 1s` (1 second)
- `time: 1000ms` (1 second)

If you do not enter a `time:` setting for a step, MPF automatically uses `time: +1`.

When shows are played, it's possible to specify a *speed* setting which is a multiplier for how fast the show is played. The default is `1.0` which would use the time values entered here, but keep in mind that it's possible to play a show back at any speed. You can even change the speed of a running show while it's in progress.

Tip: The precision of shows is limited to clock speed that MPF runs at. By default, MPF runs at 60fps, which means that each “tick” of MPF is about 16ms. So in that case, you can't get resolution of shows more precise than that.

Absolute time

The time value for each step indicates when this step will play measured in time since the start of the show. This is useful if you're synchronizing show steps with sound or video.

Relative time

Sometimes it's more convenient to specify the timing of a step in a show relative to the step before it. To do that, enter the *time* value with a `+` in front of it, like this:

```
time: +1
```

Relative step times are nice because you can adjust the timing of one step and then all the other relative steps after it are shifted back or forwards automatically.

You can mix-and-match incremental and absolute times in the same show, and you can also combine the plus sign for relative times with seconds or millisecond values. For example:

```
- time: 0    # plays right away, at 0 seconds
...
- time: +1   # plays 1 sec after the previous, 1 sec after show start
...
- time: +1   # plays 1 sec after the previous, 2 secs after show start
...
- time: 4    # plays 4 secs after show start, 2 secs after the previous
...
- time: +1   # plays 1 sec after the previous, 5 secs after show start
...
```

Note that since shows use YAML formatting, you can use the hash sign (`#`) to add comments which MPF ignores.

Setting step duration

Instead of specifying the “time” when a step starts, you can also specify the “duration” of how long a step lasts (which is essentially specifying when a step ends). The difference is subtle, but each is useful in different situations.

For example, the following two shows are identical:

```
- time: 0
  leds:
    led1: red
- time: +1
  leds:
    led1: off
- time: +1
```

```
- duration: 1
  leds:
    led1: red
- duration: 1
  leds:
    led1: off
```

You can also mix and match “time” and “duration” settings in the same show (and even in the same step). The only thing you can’t do is have a “time” setting in a step that follows a step with “duration” (since those two values would essentially mean the same thing and it would be confusing).

Setting the duration of the final step

Most people find it easiest to just use either “time” or “duration” consistently throughout a show. The only practical difference you need to think about is how the final step works.

For example, with “time”-based steps, you’re specifying the time when a step starts. So when does a step stop? When the next one starts. But what about your last step in the show? How long should it run for? If you just use time-based steps, you’d still want to specify a “duration” for the final step, like this:

```
- time: 0
  leds:
    led1: red
- time: +1
  leds:
    led1: green
- time: +1
  duration: 1
  leds:
    led1: blue
```

“Holding” the final step

You can set a duration: -1 for an “infinite” duration of a step. (Think of this like a hold or pause.) This is most useful in shows that you want to run and then hold something in their final state. For example,

maybe you want a show that runs once (no loop) and flashes a light which then stays on. You could do that like this:

```
- time: 0
  leds:
    led1: red
- time: +250ms
  leds:
    led1: off
- time: +250ms
  leds:
    led1: red
- time: +250ms
  leds:
    led1: off
- time: +250ms
  leds:
    led1: red
duration: -1
```

In this example, the LED would stay on (red) until that show was manually stopped or until the mode was stopped (if the `show_player:` entry was in a mode config file).

What can you put in shows?

In the [Show configuration format](#) page, we showed how *time* values work in shows and included some simple examples using *LEDs*. However in MPF, you can put almost anything in shows, including:

- LEDs
- Lights
- Coil & drivers
- Sounds
- Slides (for the display)
- Shows (one show can spawn other shows and/or act like a playlist)
- Events
- Random events (randomly post an event from a list of events)
- Flashers
- GI (general illumination)
- BCP commands & triggers
- Widgets (to be added or removed from slides)

The full gamut of options for each of these things is available to you in a show step.

For example, you can configure LEDs to change color, set their fade, turn off, etc. You can show slides on your display or DMD, or remove existing slides. You can post events that trigger other shows or other things to happen. You can start and stop sounds and music. The list goes on and on...

Technically-speaking, the list above is actually a list of things that MPF calls *config players*.

Config players in MPF have nothing to do with the actual human players of your machine, rather, they are things that “play” configurations.

Config players are used in the `*_player:` section of your config files *and* as steps in shows. For example, the *LED player* is used to “play” a config to LEDs, and it’s available to you outside of shows in the `led_player:` section of your config file as well as in the `leds:` section of a show.

That naming convention is the same for all the config players. You play sounds via the `sound_player:` section of a config file or the `sounds:` section of a show. Slides are played via the `slide_player:` section of a config file or the `slides:` section of a show, etc.

All of the individual config players are documented in the [config players](#) section of the documentation. You can read details about each config player there, as well as specific instructions for how to include that kind of player in a show.

Creating standalone show files

You can create a subfolder called *shows* in your machine config folder or within a mode config folder. Then inside that folder, you can create separate files, where each file is its own show. The files need to have a `.yaml` extension, and the name of the file before the extension is the name of the show as you’d refer to it in your MPF configs.

A few notes for creating show files:

- MPF config files are not case sensitive. You can mix-and-match uppercase and lowercase letters in the files, but internally MPF will not be able to differentiate between `YouShow.yaml` and `yourshow.yaml`.
- Show names are “machine-wide” within MPF. This means that if you have two different shows with the same name in different locations, MPF will get confused.
- Valid characters for show names are `z-x`, `0-9`, and the underscore. Python objects cannot contain dashes in their names, meaning your show file names cannot include dashes.

Here is a sample show file. This file might be called something like `flash_red.yaml` and would be located in your machine’s `/shows` folder:

```
#show_version=4
- time: 0
  leds:
    led1: red
- time: +1
  leds:
    led1: off
- time: + 1
```

Notice it’s essentially the same show we used as an example in the section on show config formats. However there’s one important change.

Since this is a standalone show file, we need to tell MPF what “version” of the show format this file is. MPF versions 0.30-0.33 use `show_version=4`. If we ever change something in the show format, then we’ll increment the version. (Don’t worry though, we have an automated migration tool that converts shows to the new formats. That’s actually part of the reason we include the `show_version` in the show files)

The bottom line is that when you create a .yaml show file, the first line of the file must be `#show_version=4` so MPF knows it's working with the proper type of file.

Beyond that, the show file follows the show format covered elsewhere in this documentation. You can nest show files into subfolders under the /shows folder if you want to, and in can put /shows folders in both your machine-wide and mode-specific folders. (The /shows folder should be in the root of your machine config or the root of a mode folder. It does *not* go inside the /config folder.)

Creating shows in config files

In addition to being able to [create standalone show files](#), MPF also lets you define your shows right in-line in your config files.

You can do this in the `shows:` section of a config file. (This can be done in a mode-based config or in your machine-wide config).

The actual format for a show in a config file is identical to the format of a standalone show file on disk. Basically you add a `shows:` section to a config, create sub-sections based on show name, and then add normal show items to the config. For example:

```
shows:
  flash_red:
    - time: 0
      leds:
        led1: red
    - time: +1
      leds:
        led1: off
    - time: + 1
  blue_green_cycle:
    - time: 0
      leds:
        led2: blue
    - time: +1
      leds:
        led2: green
    - time: + 1
```

The section above contains two shows: *flash_red* and *blue_green_cycle*.

Shows in files versus shows in configs

Now that you see it's possible to create shows as standalone YAML files in your *shows* folder and also in a `shows:` section of a config file, you're probably wondering what the difference is and when you should use one versus the other?

The answer is pretty simple: There is no difference.

When MPF boots up, it creates the shows objects from your show files and the show sections from configs. But once those shows are created, they are identical. No difference whatsoever. So really you can uses whichever format you want (or mix and match them). We typically create bigger and more complex shows as their own YAML files, and smaller, simpler shows in-line in the machine or mode config. But again, it really doesn't matter.

The only real difference is that if you load shows from YAML files, you can dynamically load and unload shows throughout the lifespan of MPF. (For example, you might configure it so a mode loads the shows it needs into memory when the mode starts, and then unloads them when the mode ends.) If you have lots and lots of shows and not very much memory, this could help conserve memory since shows are only loaded when they’re needed. That said, individual shows don’t take up too much memory (certainly far less than sounds and images), so in most cases this is probably moot.

One “gotcha” to keep in mind is that MPF maintains a global list of shows, so you can’t have the same show name twice (even if one is loaded from a show file and one is in a config file). If you do this, then whichever show you load last will be overwrite the previous one, and you’ll be confused.

Using “tokens” for run-time variable replacement in shows

One of the most powerful features of MPF shows is that you can build shows that contain “placeholder” tokens which are dynamically replaced with actual values when a show starts.

This lets you build reusable shows that you can then use in lots of different situations with different lights, slides, sounds, etc.

Shows without tokens

To understand how tokens work, let’s first look at a show that does not include any tokens, like this:

```
- time: 0
  leds:
    led_01: red
- time: 1
  leds:
    led_01: off
```

The example show above is simple. When it starts, it sets *led_01* to red, then 1 second later, it turns it off. You can run this show in a loop to flash *led_01* between red and off.

If you called this show *flash_red*, you could play it via the *show_player:* section of your config, like this:

```
show_player:
  some_event:
    show: flash_red
```

The problem with this show is that it’s hard-coded. It only works for *led_01*, and it only cycles the colors between red and off.

So what if you want to flash *led_01* between yellow and off? Or what if you want to flash a different LED? With a show like the example above, you’d have to write a new show for every LED with every possible color combination you’d ever want. :(

Adding tokens to shows

This is where tokens come in. Consider a slightly modified version of the show above using a token instead of a hard-coded LED name:


```
- time: 0
  leds:
    (led): red
- time: 1
  leds:
    (led): off
```

Notice the second show is identical to the first, except every reference to `led_01` has been replaced with `(led)`.

When MPF plays a show, it looks for words in the show contained in parenthesis, and then it can use those parenthesis to replace values on the fly.

So in the second show here, when you run the show, you could tell it “replace the “leds” token with the value “led_02”, which would make a show like this:

```
- time: 0
  leds:
    led_02: red
- time: 1
  leds:
    led_02: off
```

The actual way that you start and send tokens to shows varies depending on what you’re doing in MPF. (Typically they’re tied to shots or events.)

For example, here’s how you’d do it via the `show_player:`. (In this example, we also add `loops: -1` which will cause the show to loop (repeat) indefinitely.

```
show_player:
  some_event:
    flash_red:
      loops: -1
      show_tokens:
        led: led_02
```

MPF can run multiple instances of a show at the same time, so you could run the above show multiple times (at the same time), passing different tokens to each one, meaning you could use the same show to flash lots of lights at once:

```
show_player:
  some_event:
    flash_red:
      loops: -1
      show_tokens:
        led: led_02
  some_other_event:
    flash_red:
      loops: -1
      show_tokens:
        led: led_03
```


Putting multiple values into a single token

You can also use tags to insert multiple values into a single token. For example, consider the following section from your machine config:

```
leds:
  led_01:
    number: 00
    tags: tag1
  led_02:
    number: 01
    tags: tag1
```

You can see that both *led_01* and *led_02* have the *tag1* tag applied. So if you play the show above (with the *leds* token), you can actually pass the tag name to the token instead:

```
show_player:
  some_event:
    flash_red:
      loops: -1
      show_tokens:
        led: tag1
```

This would result in a show that was equivalent to:

```
- time: 0
  leds:
    led_01: red
    led_02: red
- time: 1
  leds:
    led_01: off
    led_02: off
```

Token names are arbitrary

The token show we’ve been working with so far includes a token called *leds*. That’s a good name for the token since it explains what it’s for. However, MPF doesn’t care what the actual token name is. All it’s doing is a find-and-replace when the show starts with whatever token names it was passed.

For example, this is a perfectly valid show:

```
- time: 0
  leds:
    (corndog): red
- time: 1
  leds:
    (corndog): off
```

In this case, you’d just pass a value for the *corndog* token when you play the show:

```
show_player:
  some_event:
    flash_red:
```



```
loops: -1
show_tokens:
  corndog: led_02
```

Tokens can be values too

You can use tokens anywhere in a show. The actual find-and-replace is pretty simple, just looking for words in parentheses and then substituting them with the tokens key/value pairs that were passed when the show starts.

You can also pass multiple tokens. Consider the following show:

```
- time: 0
  leds:
    (led): (color1)
- time: 1
  leds:
    (led): (color2)
```

Notice there are three tokens in this show: *led*, *color1*, and *color2*. You might call this show *color_cycle*, which you could then play like this:

```
show_player:
  some_event:
    color_cycle:
      loops: -1
      show_tokens:
        led: led_02
        color1: green
        color2: blue
```

The bottom line

As you can see, tokens are very powerful. Again, keep in mind there are many different ways to start shows in MPF, and all of them have ways to pass tokens to shows.

Starting & stopping shows

Now that you know how to create shows, how do you start and stop them?

The easiest way is with the [show_player](#): section of either a machine-wide or mode config files.

You can use the show player to start, stop, pause, resume, advance, step back, and update shows. (That's a lot!) You can also use it to set the playback speed, set up show synchronization, and set up show repeats and looping.

Note that any shows which were started via a `show_player:` section in a mode config file will automatically be stopped when that mode stops.

So check the [show_player](#): documentation for details.

Synchronizing multiple shows

One thing you might notice in professional pinball machines is that all the lights flash in sync with each other. But in MPF, if you have lots of separate shows, then you'll notice they all sort of start randomly when they start, and it looks bad because they're not all perfectly aligned with each other.

MPF solves this by incorporating a "sync_ms" setting when playing shows. When you add this setting to a show and then play it, MPF will not start the show until the next exact multiple of that number from zero.

For example, if you have sync_ms: 500, then MPF will start a show at the exact second or half second. (e.g. the seconds value of the current time will either be .0 or .5).

If you have sync_ms: 250, then shows will be delayed and start at the nearest quarter second, either .0, .250, .5, or .750 past the second.

You only need to use the sync_ms setting for the specific shows you want to keep in sync. Typically this would be used for light or LED shows, as new shows starting should align nicely to existing shows that are already running.

The value of sync_ms you should use should be one complete "cycle" of the show. For example, if you flash your lights or LEDs at a rate of 250ms on / 250ms off, then you should use sync_ms: 500 to ensure every show starts at the nearest 500ms point, thus ensuring that all lights will be "on" or "off" at the same time. (If you set sync_ms: 250 in this case, then your shows will be in sync but they might be offset from each other.)

If your show is 200ms on / 200ms off, set sync_ms to 400. If your show is 400ms on / 250ms off, set sync_ms to 650. Etc.

If you're wondering whether sync_ms is bad because it delays a show start, and you don't want a show to be delayed, don't worry about it. The main use for sync_ms is when you have lights or LEDs that are flashing repeatedly, and in those cases, there's so much other stuff happening when they start flashing that no one is going to notice a delay of a fraction of a second when the show starts. (This is how it has to work anyway since you want the lights to be in sync.)

CHAPTER 14

Assets

Assets are files that your machine uses that are loaded from disk, such as show YAML files, images, and sound files. MPF has lots of flexibility for how assets are loaded and unloaded. (For example, if you're running MPF on a machine that doesn't have a lot of memory, you may not be able to load all the assets at startup and may instead have to dynamically load and unload assets throughout the game.)

MPF also has the ability to automatically “discover” various types of assets in your machine folder, meaning you don't have to manually type every single asset file name into your config files. You can even set asset properties based on what folder and/or subfolder they're in. (For example, audio files in /sounds/fx are automatically played on the sound effects track, while sound files in /sounds/voice are played on the voice track.

As of MPF 0.33, assets can be in nested subfolders too. For example:

```
\sounds
\sounds\fx
\sounds\fx\pops
\sounds\fx\slings
\sounds\voice\red
\sounds\voice\ted
\sounds\voice\bob
```

MPF also supports “asset pools” for sound and image assets which allow you to group multiple asset files into a single asset name that you use in MPF. This lets you add “variation” to assets during game play. For example, if you have a laser sound when a pop bumper is hit, you could actually have four different laser sound files that are each slightly different which you pool into the “laser” asset which is associate with the pop bumper, and then each time the pop bumper is hit you get one of the four sounds played at random instead of the same sound over and over.

Creating “pools” of assets

todo

Images (asset type)

todo

Shows (asset type)

todo

Sounds (asset type)

todo

Videos (asset type)

todo

CHAPTER 15

Config Players

An important concept to using the YAML-based configuration files is something we call *config players*.

Config players in MPF have nothing to do with the actual human players of your machine, rather, they are things that “play” based on configurations.

Config players are used in both the machine-wide and mode-specific config files, and also in show steps.

- In a config file, the config players are setup via the `<config_player_name>_player:` section of the file.
- In show steps, config players are accessed via the `<config_player_name>s:` setting.

Some examples:

- You play sounds via a config file in the `sound_player:` section, and you play sounds from a show step via the `sounds:` setting for that step.
- You show slides on a display via a config file in the `slide_player:` section, and you show slides from a show step via the `slides:` setting for that step.
- You set the color of LEDs via a config file in the `led_player:` section, and you set colors from a show step via the `leds:` setting for that step.
- etc.

There are several different config players in MPF and MPF-MC. Click on each below for specific details of how to use them, with explanations of how to use them in config files and in shows.

BCP player

The *BCP player* is a *config player* that’s used to send BCP messages.

Usage in config files

In config files, the BCP player is used via the `bcp_player:` section.

Usage in shows

In shows, the BCP player is used via the `bcps:` section of a step.

Coil player

The *coil player* is a *config player* that's used pulse, enable, or disable coils and drivers.

Usage in config files

In config files, the coil player is used via the `coil_player:` section.

Usage in shows

In shows, the coil player is used via the `coils:` section of a step.

Event player

The *event player* is a *config player* that's used to post events.

Usage in config files

In config files, the event player is used via the `event_player:` section.

Usage in shows

In shows, the event player is used via the `events:` section of a step.

Flasher player

The *flasher player* is a *config player* that's used to flash flashers.

Usage in config files

In config files, the flasher player is used via the `flasher_player:` section.

Usage in shows

In shows, the slide flasher is used via the `flashers:` section of a step.

GI (general illumination) player

The *GI player* is a *config player* that's used to turn GI strings on or off.

Usage in config files

In config files, the GI player is used via the `gi_player:` section.

Usage in shows

In shows, the GI player is used via the `gis:` section of a step.

LED player

The *LED player* is a *config player* that's used to set the color of LEDs (including fade rates).

Usage in config files

In config files, the LED player is used via the `led_player:` section.

Usage in shows

In shows, the LED player is used via the `leds:` section of a step.

Light player

The *light player* is a *config player* that's used to set the brightness of matrix lights (including turning them on and off).

Usage in config files

In config files, the light player is used via the `light_player:` section.

Usage in shows

In shows, the light player is used via the `lights:` section of a step.

Plugin player

The *plugin player* isn't a regular config player, rather, it's a stub that developers can use to add their own types of config players.

For example, MPF-MC uses the plugin player to add three additional config players: *slide player*, *widget player*, and *sound player*. Since sounds and display are handled by MPF-MC, the MPF core doesn't know anything about sounds or displays, so this is how MPF-MC is able to add its features to MPF shows and config files.

Queue Event player

The *queue event player* is a *config player* that's used to play queue events.

Usage in config files

In config files, the event player is used via the `queue_event_player:` section.

Usage in shows

None. (It's not valid in shows since it doesn't make sense in shows.)

Queue Relay player

The *queue relay player* is a *config player* that's used to block queue events.

Usage in config files

In config files, the event player is used via the `queue_relay_player:` section.

Usage in shows

None. (It's not valid in shows since it doesn't make sense in shows.)

Random event player

The *random event player* is a *config player* that's used to post random events from a list of events.

Usage in config files

In config files, the random event player is used via the `random_event_player:` section.

Usage in shows

In shows, the random event player is used via the `random_events:` section of a step.

Show player

The *show player* is a *config player* that's used to start, stop, pause, resume, advance, and/or update shows.

Usage in config files

In config files, the show player is used via the `show_player:` section.

Usage in shows

In shows, the show player is used via the `shows:` section of a step. (Yes, you can include shows in shows, meaning you can essentially use a parent show like a playlist, or as a controller that starts and stops other shows.)

Slide player

The *slide player* is a *config player* in the MPF media controller that is used to play slide content, including showing slides, hiding slides, and removing slides. (This player is part of the MPF media controller and only available if you're using MPF-MC for your media controller.)

Usage in config files

In config files, the slide player is used via the `slide_player:` section.

Usage in shows

In shows, the slide player is used via the `slides:` section of a step.

List of settings and options

Refer to the *slide_player* section of the config file reference for a full explanation of how to use the slide player in both config and show files.

Sound player

The *sound player* is a *config player* that's used to control sounds. (This player is part of the MPF media controller and only available if you're using MPF-MC for your media controller.)

Usage in config files

In config files, the sound player is used via the `sound_player:` section. Event names that will trigger sound actions are nested sub-headings and sound names are either listed as nested sub-headings below that.

Usage in shows

In shows, the sound player is used via the `sounds:` section of a step.

Optional settings

Additional information may be found in the [sound_player](#) configuration reference documentation.

Track player

New in version 0.32.

The *track player* is a [config player](#) that's used to control audio tracks when MPF events are received. Tracks can be stopped, paused, or played with an optional fade time. The volume of a track can also be changed with an optional fade time. Finally, all sounds currently playing on a track can be stopped (again with an optional fade out time). (This player is part of the MPF media controller and only available if you're using MPF-MC for your media controller.)

Usage in config files

In config files, the track player is used via the `track_player:` section. Event names that will trigger track actions are nested sub-headings and track names are listed as nested sub-headings below that.

Usage in shows

In shows, the track player is used via the `tracks:` section of a step.

Required settings

Additional information may be found in the [track_player](#) configuration reference documentation.

Trigger player

The *trigger player* is a [config player](#) that's used to send BCP triggers to remotely- connected BCP devices. This isn't typically used much if you're using the MPF Media Controller (since MPF-MC can read MPF config files), but it's used a lot if you're using a different media controller that doesn't know as much about MPF (such as the Unity 3D backbox server).

Usage in config files

In config files, the trigger player is used via the `trigger_player:` section.

Usage in shows

In shows, the trigger player is used via the `triggers:` section of a step.

Widget player

The *widget player* is a *config player* that's used to add or remove widgets to existing slides on a display. (This player is part of the MPF media controller and only available if you're using MPF-MC for your media controller.)

Usage in config files

In config files, the widget player is used via the `widget_player:` section.

Usage in shows

In shows, the widget player is used via the `widgets:` section of a step.

CHAPTER 16

Machine Management

MPF includes many features to help you manage your pinball machine.

(There's a lot to add here. This will include things like the service mode, auditor, remote monitoring and trouble reporting, etc.)

Auditor

The Mission Pinball Framework contains an auditor that can be used to create audit logs of switch events, game events, shots made, and player variables. The exact behavior of what is (and isn't) included in the audit log is controlled in the Auditor section of your machine configuration files. Here's a sample audit file:

```
Events:
  ball_search_begin: 0
  ball_started: 1
  game_ended: 31
  game_started: 41
  machine_init_phase_1: 0
  machine_reset: 29
Player:
  score:
  average: 15634
  top:
  - 71130
  - 59840
  - 50190
  - 47490
  - 39350
  - 33350
  - 25700
  - 24890
```



```
- 21980
- 21670
total: 31
Shots:
AirRaidRamp: 3
DropTarget: 99
FullRightOrbit: 5
Inlane: 54
LeftOrbit: 13
LeftRamp: 4
OrangeStandups: 11
Outlane: 14
RightRamp: 7
Slingshot: 105
WeakRightOrbit: 6
Switches:
ShooterLaneL: 20
alwaysClosed: 0
buyIn: 0
captiveBall1: 22
captiveBall2: 10
captiveBall3: 2
centerRampExit: 16
coin1: 0
coin2: 0
coin3: 0
coin4: 0
coinDoor: 0
craneRelease: 0
down: 0
dropTargetD: 9
dropTargetE: 51
dropTargetG: 45
dropTargetJ: 38
dropTargetU: 47
enter: 98
esc: 80
fireL: 0
fireR: 122
flipperLwL: 400
flipperLwL_EOS: 388
flipperLwR: 440
flipperLwR_EOS: 434
flipperUpL: 364
flipperUpL_EOS: 360
flipperUpR: 440
flipperUpR_EOS: 436
globePosition1: 108
globePosition2: 108
inlaneL: 40
inlaneR: 38
leftRampEnter: 24
leftRampExit: 8
leftRampToLock: 4
leftRollover: 136
```



```
leftScorePost: 42
magnetOverRing: 0
mystery: 8
outerInlaneR: 30
outlaneL: 22
outlaneR: 6
plumbBob: 0
popperL: 36
popperR: 20
rightRampExit: 14
rightTopPost: 28
shooterR: 106
slamTilt: 0
slingL: 134
slingR: 76
start: 47
subwayEnter1: 16
subwayEnter2: 16
superGame: 0
threeBankTargets: 22
ticketDispenser: 0
topCenterRollover: 24
topRampExit: 6
topRightOpto: 36
trough1: 120
trough2: 96
trough3: 96
trough4: 96
trough5: 96
trough6: 74
troughJam: 76
up: 0
```

Note that in the ‘Player’ section, the auditor will track the average, the Top 10, and the total numbers of each item. You can configure all this (including how many of each item it records) in the auditor: section of the configuration file’.

Service Mode

TODO

Operator Settings

TODO

There are several tools which have been created to help you build your game in MPF.

MPF Monitor

The MPF Monitor is a graphical utility you can use to interact with a running instance of MPF. See lights change in action, click to control switches, and lay out everything on an image of your playfield.

“Interactive” MC (or “iMC”)

The interactive MC lets you create YAML configurations for slides and widgets in realtime and see them on a display. This is great for fine tuning and tweaking your slides.

Future Tools

- GUI config builder
- Music builder / looper / manager
- Show builder
- Slide / animation tool
- Auto machine documentation builder
- Machine fuzzer
- Device / asset explorer (Why did this sound stop? Why is this LED red? etc)

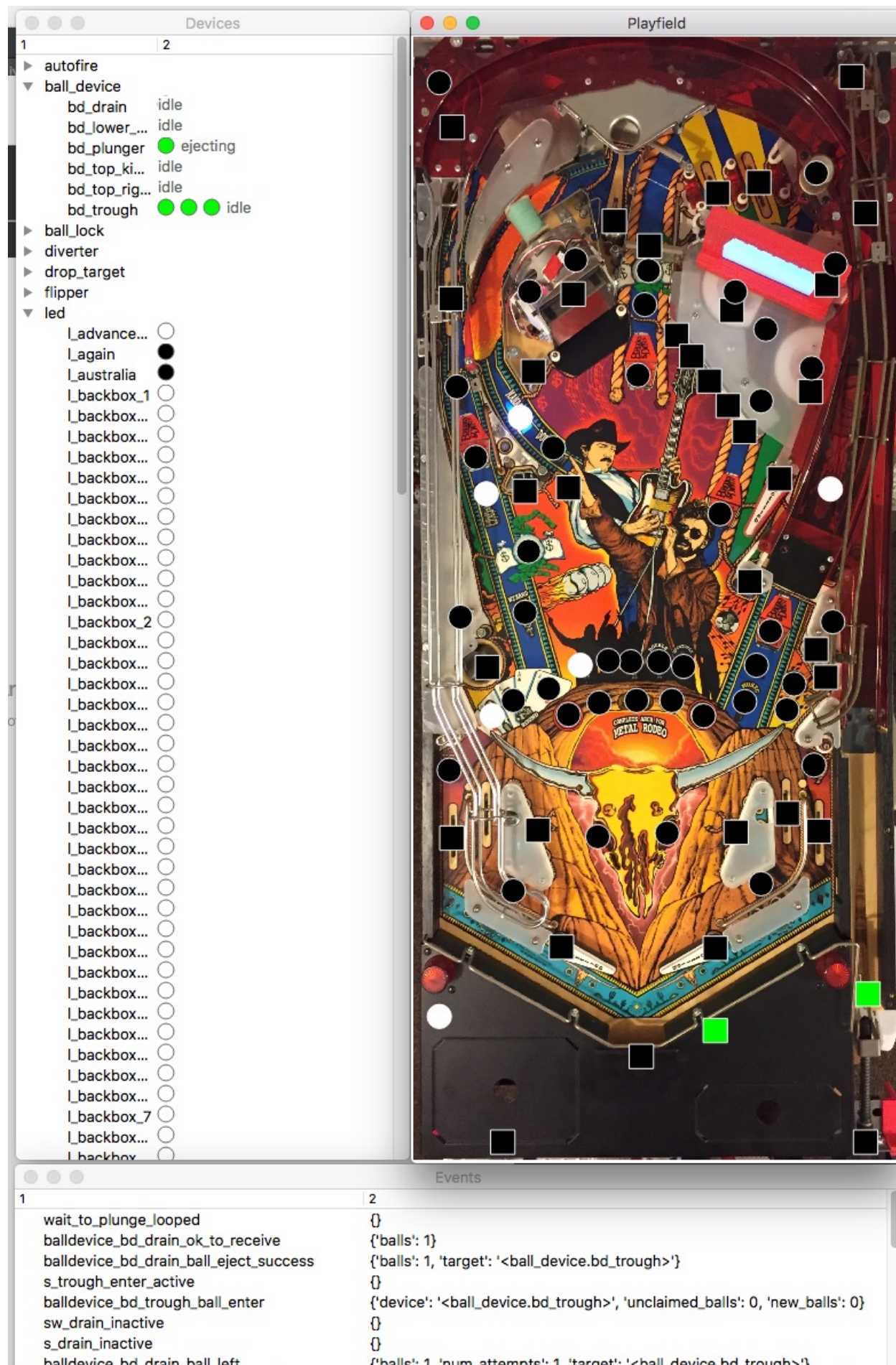
The MPF Monitor

The MPF monitor is a graphical app that connects to a live running instance of MPF and shows the status of various devices. (LEDs, switches, ball locks, etc.) as well as a running list of recent [MPF events](#). You can add a picture of your playfield and drag-and-drop devices to their proper locations so you can interact with your machine when you're not near your physical machine and/or for developing your game. MPF Monitor is also great when you have more than one person working on your MPF code but your physical machine is at one person's house. :)

The MPF Monitor can run on Windows, Mac, and Linux. It uses [PyQt5](#) (Python bindings for Qt5) for its visual framework.

Here's a screen shot of it in action:

Note: The MPF Monitor is *not* a full pinball simulation with physics or moving balls or anything. But it does enough that you can use it to do real work on a machine when that machine is not nearby.



Features

- Connects to a live running instance of MPF.
- Automatically discovers all the pinball mechs and devices in the game.
- Device state is updated in real time in the “Devices” window.
- MPF events and their keyword arguments are posted in real time to “Events” window.
- You can add a photo of your playfield and then drag-and-drop LEDs, lights, and switches from the device tree onto the playfield.
 - LEDs (circle icons) show their color in real time.
 - Lights (circle icons) show their brightness in real time between black and white.
 - Switches (square icons) show their state (green = active, black = inactive).
 - More device types will become “draggable” in the future.
- Left-click on a switch to “tap” it (activate & release). Right-click on a switch to “toggle” it (change its state and hold it).
- Devices added to the playfield image are saved & restored when you restart the monitor.
- Window sizes, positions, and which windows are open are remembered and restored on next use.
- You can start the monitor and leave it running, and it will automatically connect (and disconnect/reconnect) to MPF as MPF starts and stops.

Road Map Features

MPF Monitor is very rough at this point. (Really more of a proof-of-concept.) We plan to add more features, including:

- More details for events, including listing registered handlers & making it so you can sort, search, and clear the list.
- Adding all the “game logic” stuff, including modes, shots, shot groups, shot profiles, logic blocks, timers, ball locks, multiballs, achievements, etc.
- Add shows (running shows, step they’re on, priority, etc.)
- Add players information (show all player variables and their values)
- A “snapshot” button that can dump the entire current state to a file for debugging later
- Export position (x/y) settings of widgets back to the MPF config
- Connect to MPF-MC to get information about slides, displays, widgets, etc.
- Add color controls to the playfield image to set brightness and color saturation
- Add buttons to enable/disable different types of devices (think of it like “layers” for the playfield image).
- Show additional properties from the selected device (Click a device to see it’s full information.)
- Change debug levels of various devices dynamically
- Save the config / layout with a specified file name
- Add multiple playfield views which could each have different devices

- Set colors, shapes, rotation, & sizes of devices (so inserts can be the right shape). Allow configurable “off” colors which can include opacity and “glow” so inserts look like real lights.
- Allow all devices to be added to the playfield image, with custom representation (diverters that animate, flippers that animate, etc.).
- Device state change history that shows what properties changed and when.
- Default (mostly blank) playfield image if no playfield image is specified
- Configurable default options (folder location, playfield image name, etc.)

Next Steps

Installing the MPF Monitor

Here’s how you install the MPF Monitor. These instructions are a bit rough since MPF Monitor is an early prototype.

Windows

1. Install PyQt5 from here: <https://sourceforge.net/projects/pyqt/files/PyQt5/PyQt-5.5.1/> Just choose all the defaults and you should be ok.
2. Open a command prompt and run: (You can run this from any folder)

```
pip install mpf-monitor
```

Note: If you originally ran “pip” in a different way, perhaps with pip3 or python3 -m pip, then do that again here instead of the plain “pip”.

To update MPF Monitor to the latest version at any time, run:

```
pip install mpf-monitor --upgrade
```

Note that since MPF Monitor is a separate app from MPF and MPF-MC, the version numbers of the Monitor and MPF are not the same. (For example, the same version of MPF Monitor can work across several versions of MPF.)

Mac

Open a terminal window and run the following command: (You can run this from any folder)

```
pip3 install mpf-monitor
```

To update MPF Monitor to the latest version at any time, run:

```
pip3 install mpf-monitor --upgrade
```

Note that since MPF Monitor is a separate app from MPF and MPF-MC, the version numbers of the Monitor and MPF are not the same. (For example, the same version of MPF Monitor can work across several versions of MPF.)

Linux

Note that these instructions assume you're running Python 3.5. If you're running Python 3.4, you'll need to first manually download and install [PyQt5](#). You could also potentially run `apt-get install python3-pyqt5`.

Install mpf-monitor via pip:

```
pip install mpf-monitor
```

To update MPF Monitor to the latest version at any time, run:

```
pip install mpf-monitor --upgrade
```

Note that since MPF Monitor is a separate app from MPF and MPF-MC, the version numbers of the Monitor and MPF are not the same. (For example, the same version of MPF Monitor can work across several versions of MPF.)

Running the MPF Monitor

1. Make sure you installed MPF Monitor first. (You need to actually [run the installer](#). You can't just run the monitor from the download folder.)
2. Create a subfolder in your MPF machine folder called `/monitor`
3. Put an image of your playfield in that folder named `playfield.jpg`
4. Run MPF monitor from a command prompt in a new window via the command `mpf monitor`. Be sure to run this from your machine folder (the same place where you run `mpf` both).
5. Start MPF and MPF-MC. (You can start MPF before or after monitor is started, and leave the monitor running while MPF is not.)
6. MPF Monitor should connect to MPF and populate the devices tree. You can look through there to see the states of various devices. The columns are sortable and resizable.
7. Drag-and-drop switches and LEDs onto the playfield image. When you do this, a config file called `/monitor/monitor.yaml` will be created. If you open that file, you'll see that x/y values of devices are stored in percentages instead of pixels, so they should stay in the right place even if you change your playfield image. The file is updated automatically. You can drag devices that you previously placed on the playfield too (there's a half-second delay so you don't accidentally move something when you're clicking on it.)
8. Edit `monitor.yaml` to remove devices from the playfield you don't want anymore.
9. When you resize or reposition one of the monitor windows, a file called `/monitor/layout.yaml` will be created that contains the window positioning information so the monitor can restore the layout the next time you run it. (If you use MPF from multiple computers, don't sync the layout file so each computer can have its own settings.)

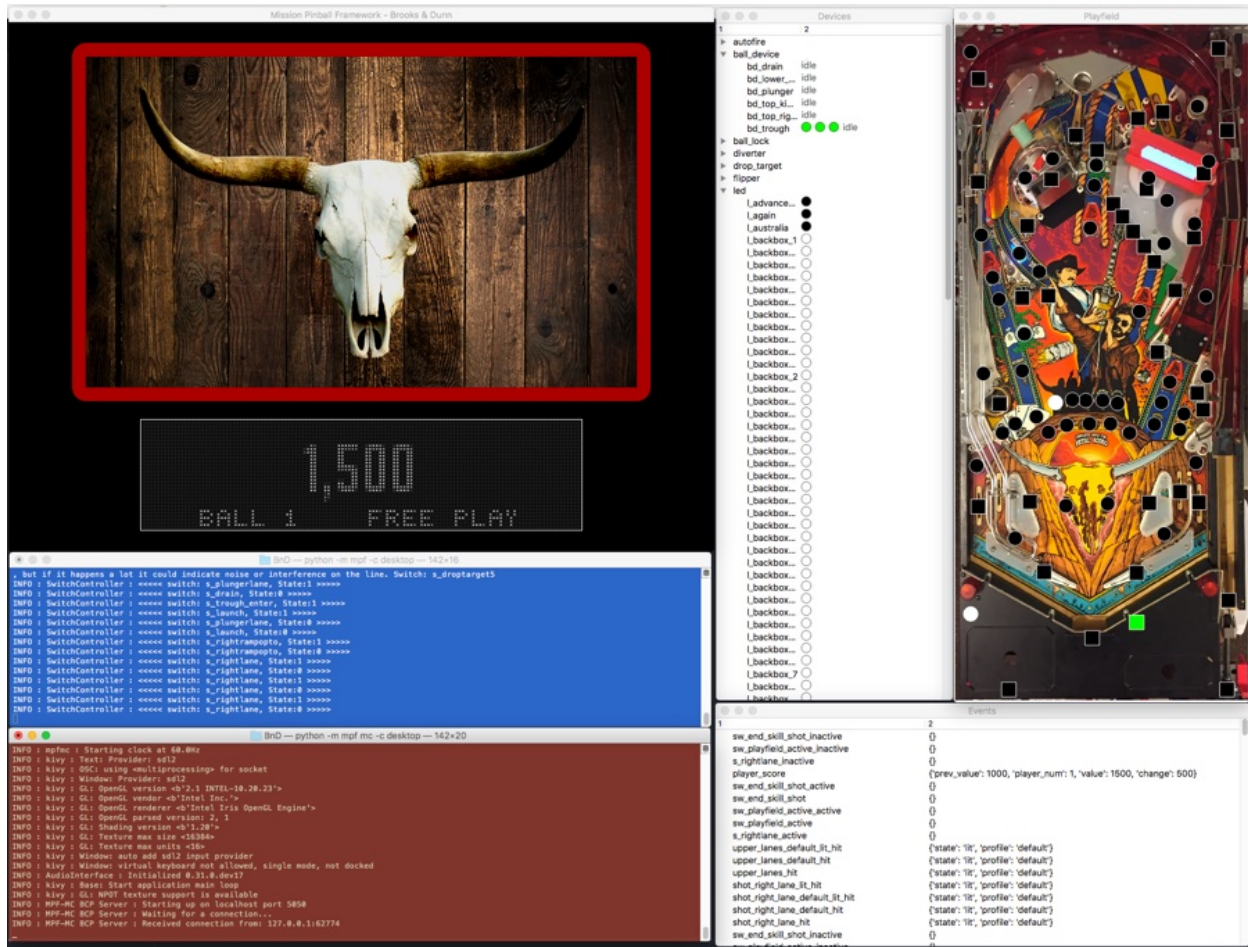
Understanding MPF Monitor folders & files

Here's what your machine folder structure will look like when you're using the monitor:



Using the MPF Monitor

We designed MPF Monitor so that all the windows are separate (instead of a main “parent” window), meaning you can resize them all however you want and close the ones you don’t need. The idea is that you can keep the monitor running off to the side and still see your MPF display window as well as the terminal windows, like this:



Running with “virtual” hardware

You can use the MPF Monitor with or without a physical machine attached.

If you have a physical machine connected, be careful when toggling switches, since it can really confuse things if a ball is sitting on a switch in your machine and then you use the Monitor to tell MPF that the ball isn’t really there. :)

Still though it’s nice to be able to “peek inside” the inner workings of MPF even when it’s connected to a physical machine, and the Monitor is great for that.

You can also use MPF Monitor with no hardware attached using one of MPF’s *virtual platforms*. Specifically the *smart virtual platform* works great if you’re using MPF without physical hardware.

Interactive MC (iMC)

The MPF MC package includes an “interactive” MC which you can use to live-edit YAML configurations for slides and widgets and see the results in realtime in your on-screen window.

Running the iMC does two things:

1. It launches the MC like normal, loading your game’s config files.

2. It launches a second window which has a multi-line editable text box where you can type or past slide configs.

The idea is you can use the iMC to keep tweaking and fine-tuning your slide and widget settings in a way that's much easier than starting your game and going through your game to find the slide you're looking for.

Note: The iMC does not connect to physical hardware, so if you have a physical DMD then you will have to test with an on-screen virtual DMD.

Since the iMC uses the regular MC and the regular config files, you have access to all the named widgets, images, videos, widget styles, fonts, etc. from your machine config.

TODO

MPF Test Functions

Here's a list of test functions you can use for your own machine.

todo

MpfGameTestCase

assertBallNumber(number) assertPlayerNumber(number) assertGameIsRunning()
assertGameInNotRunning()

MpfTestCase

assertColorAlmostEqual(color1, color2, delta=6) assertPlayerVarEqual(value, player_var)
assertSwitchState(name, state) assertLedColor(led_name, color) assertLedColors(led_name, color_list,
secs, check_delta=.1) assertModeRunning(mode_name) assertModeNotRunning(mode_name)
assertEventNotCalled(event_name) assertEventCalled(event_name, times=None)
assertEventCalledWith(event_name, kwargs) assertShotShow(shot_name, show_name)
assertShowRunning(show_name) assertShowNotRunning(show_name) assertBallsOnPlayfield
assertAvailableBallsOnPlayfield assertShotProfile assertShotState assertShotEnabled

add utility functions

MpfMcTestCase

assertEventNotCalled(event_name) assertEventCalled(event_name, times=None)
assertEventCalledWith(event_name, kwargs)

MpfSlideTestCase

assertSlideOnTop(slide_name, target='default') assertTextOnTopSlide(text, target='default')
assertTextNotOnTopSlide(text, target='default') assertSlideActive(slide_name)

```
assertSlideNotActive(slide_name) assertTextInSlide(text, slide_name) assertTextNotInSlide(text,  
slide_name)
```


CHAPTER 19

Finalizing your machine

This section will discuss all the “final” steps you need to take to get your machine ready to run without you.

Most of this is TODO

Choosing a computer to run MPF

Please make sure you read the [Choosing a PC for MPF](#) section first.

In this section we talk about a potential production setup. Thus, this is mostly about compromises. What is the minimal (e.g. most cost effective) hardware? You probably want to tune your game first.

TODO

Single-board versus “real” computers?

Picking an OS

The checklist

Now that you’ve read about all the background information that goes into picking a host computer, let’s break it down into the questions you need to answer to pick the one that makes sense for you.

What OS are you familiar with?

More and more commercial machines are running Linux. But if you’re comfortable with Windows and you’ve never used Linux, then by all means do not put a Linux computer in your pinball machine. It’s just not worth the headache. Sure, this might mean that you have to buy a \$150 motherboard/SSD/RAM/PSU combination versus a \$50 single board computer, but meh, that 100

bucks will be worth it in terms of future pain avoided. And besides, pinball machines cost thousands of dollars to build. What's another 100 bucks to make your life easier?

Do you have anything you can use now?

The best host computer is the one that you already have. :) Seriously, if you have something laying around, just start using it. You can always change it out later. BTW, we've received a few questions from people wanting to use Mac Minis.

Is this a one-off machine, or are you taking something into production?

What are your graphics and display requirements?

The Bottom Line

Remember that MPF and Python work identically regardless of whether they're running on Windows, Mac, or Linux. So even if you pick the "wrong" host computer now, you can always change it out later without having to change any of your code or configuration files. So if you have an old laptop sitting around then go ahead and use it for MPF. You can always swap it out with a small single-board computer down the road.

Choosing an OS for your final machine

TODO

Talk about "Freezing" it, lock down, recovery, auto booting, etc.

Controlling your machine & computer power on / power off

TODO

Enabling & fine-tuning ball search

TODO

Fine-tuning ball device timing

TODO

Fine-tuning switches

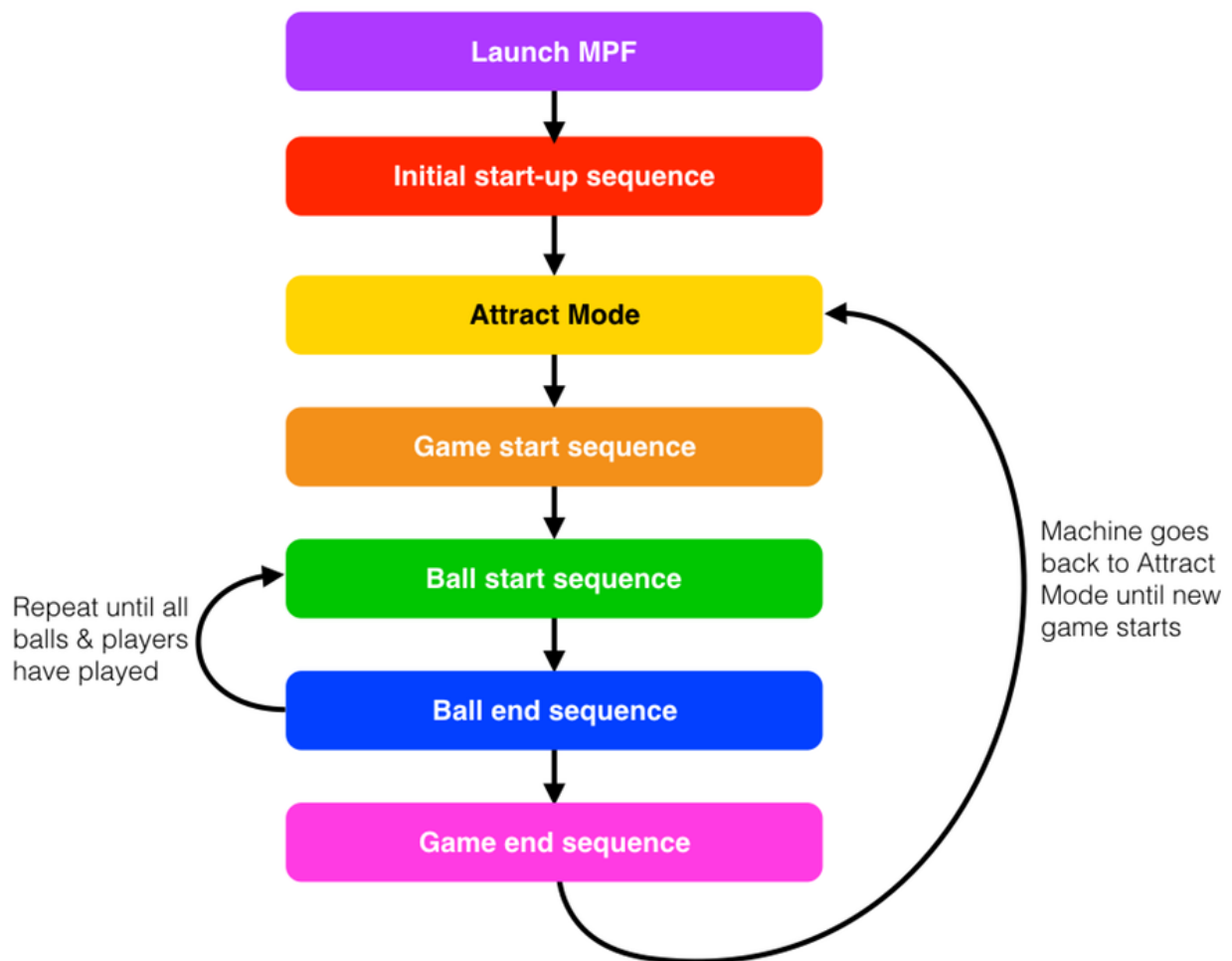
TODO

Talk about debounce, also broken switch detection, alternative workarounds, etc.

CHAPTER 20

Flowcharts

The software that runs a pinball machine is really complex. Even though MPF hides a lot of that complexity from you, it's still helpful to know exactly what's going on under the hood. This diagram shows the high level flow. Read on to see the details of each step.



MPF Boot Up / Start Up Sequence

The first phase of operation of MPF is the start up sequence which is basically everything that takes from from the time you run mpf until the time your machine is up and running in attract mode. We're not going to list every single detail here—to see that just look at a log file generated in verbose mode—but this should give you a pretty high level gist:

1. Loads the configuration from file: <your MPF project root>/mpf/mpfconfig.yaml
2. Loads the machine config file you specified in the command line. Note that this config file may load other config files.
3. Sets the default hardware platform. (FAST, P-ROC, OPP, SPIKE, virtual, etc.)
4. Loads the system modules. The exact order is specified in mpfconfig.yaml. Currently it's:
 - (a) config_processor
 - (b) timing
 - (c) event manager
 - (d) mode controller

- (e) Device manager
 - i. Device modules are loaded
 - ii. Machine-wide devices are created
 - (f) switch controller
 - (g) ball controller
 - (h) light controller
 - (i) bcp
 - (j) logic blocks
 - (k) scoring
 - (l) shot profile manager
5. System events are registered (for things like shutdown, quit, etc.)
 6. Posts the event *init_phase_1* .
 - (a) The event player is initialized
 7. Posts the event *init_phase_2* .
 - (a) The ball controller configures eject targets
 - (b) The playfield configures eject targets
 - (c) Score reels configure their switches
 - (d) BCP sets up connections
 - (e) The switch controller sets up switch events
 - (f) The device manager registers all the control_events for machine- wide devices
 8. Plugins are loaded
 9. Posts the event *init_phase_3* .
 - (a) The ball lock devices initialize
 - (b) Diverters register for switches
 - (c) The shot profile manager registers shot profiles
 10. Scriptlets are loaded
 11. Posts the event *init_phase_4* .
 - (a) Drop targets update their states from their switches
 - (b) The auditor initializes
 - (c) OSC starts
 - (d) The asset managers start loading machine-wide assets
 - (e) The mode controller processes and loads all the modes
 12. Posts the event *init_phase_5* .
 - (a) The light controller processes machine-wide light scripts and light player entries
 13. The machine controller's reset() method is called.

14. Reset posts the event *machine_reset_phase_1*.
 - (a) Ball devices initialize their switches
 - (b) BCP sends the reset command to any attached media controllers
15. Reset posts the event *machine_reset_phase_2*.
 - (a) The ball controller updates its count of known balls
 - (b) Ball devices configure their eject targets
16. Reset posts the event *machine_reset_phase_3*.
 - (a) Ball locks are reset
 - (b) Drop targets are reset
 - (c) Drop target banks are reset
 - (d) GI is enabled
 - (e) Multiball devices are reset
 - (f) The attract mode starts as its a registered handler for *machine_reset_phase_3* .

Game Start Sequence

This sequence document starts with the attract mode running and ends with the running.

1. The player pushes a button tagged with “start”. The time is noted.
2. The player releases that button. (This is important because in MPF it’s possible to do different things based on a so-called “long press” of the start button. For example, you might start the machine in tournament mode, or allow players to select a player profile. So the game start process doesn’t actually begin until the start button is released.)
3. The Attract mode posts the boolean event **request_to_start_game*. See the section below about the “How the **request_to_start_game* event works.”
 - (a) The ball controller makes sure there are enough balls and that they are all gathered.
 - (b) Other modules make sure they are ready for the game to start and deny it if not.
4. The attract mode’s *result_of_start_request* is the callback for the request event. If the result is True, this process continues.
5. The attract mode posts an event *game_start*.
6. The game mode is registered as a handler for the *game_start* event, so it starts.
7. The game mode posts a queue event called *game_starting*.
 - (a) The score reels reset themselves
 - (b) The auditor enables itself
 - (c) Info lights reset
8. The game mode’s *game_start()* method is the callback for that queue event which is called when that event is finished.
9. The game mode calls its *_player_add()* method.

- (a) The first player is created
 - (b) The number of players is updated
10. The game mode posts the event *game_started* .
 11. The game mode calls its *player_turn_start()* method.

At this point we have a running game!

How the “request_to_start_game” event works

When a player pushes (and releases) the start button during attract mode, the Attract Mode code posts an MPF event called *request_to_start_game*. This event is not a normal event that is just posted and forgotten, rather, it’s a special type of event called a “boolean event.” When a system component posts a boolean event, it actually watches for responses from every other component that is watching for that event. If this event is posted and nothing speaks up to stop it, then the module that posted that event will continue. But if anything “kills” that event, that will cause whatever module that posted it to *not* proceed. This can be a bit confusing, so let’s go through this in plain English:

1. When a player pushes and releases the start button, the attract mode says, “Hey! I’d like to start a game now. Does anyone have a problem with that?”
2. This gives other components a chance to pipe up and say, “Yeah! I have a problem with that. You’re not starting a game!”
3. If no one speaks up, the attract mode will say, “Ok, I’m posting a follow up event to kick off the game start process.”
4. But if any component denies the start, then the attract mode will do nothing, and the game doesn’t start.

So what types of components might register to watch for and/or interrupt the game start request? Lots of them.

The ball controller watches for this event and will make sure that the game has the minimum number of balls installed, and that those balls are all in their “home” positions. If everything is ok when the game start request comes in, then the ball controller will do nothing, allowing the start to proceed. But if the start request comes in and the ball controller doesn’t have enough balls, it will “kill” the start request, and the game won’t start. (When something kills an event like this, it’s up to that component to make it obvious to the player what’s going on. For example, the ball controller might put a message on the DMD which says something about balls being missing.)

Another component that might care about this game start request is the credits module. If the machine is *not* set to free play, then when the *request_to_start_game* event is posted, the credits module will make sure there’s at least one credit on the machine. If not, then it will kill the event and not allow the game to start.

At this point you might be wondering what the point of all this is? Why have these start request events? Isn’t this overly complicated? Why not just have MPF check all these things on its own?

The beauty of these types of events is that it makes it easy to customize and add features and components to MPF without the core MPF software knowing (or caring) what’s installed and what might be starting an event. The MPF core doesn’t know about credits or free play or any of that. It just says, “Hey, I want to start a game. Is that cool?” If you don’t have a credits module, or if the credits module isn’t active because the machine is on free play, then the credits module isn’t there to deny the

start and MPF can start the game no problem. But if then if you add or enable the credits module, then this start request process is what gives that random module a “hook” into the game starting process.

The real power of this comes with future flexibility. You might want to create some other type of component that we never thought of. (Maybe you don’t want any new games to start after 11pm or something?) Thanks to this request event, you can write your own module as a simple snap- in which “hooks” this game start event, and MPF doesn’t need to know about the details, and you don’t have to resort to a “hack” of the MPF core to hook in whatever future crazy module you have. It’s very cool!

Ball Start Sequence

This sequence shows everything that happens when a new ball starts in MPF. There are actually a few different ways we can end up here: If this the first ball of the first player in a new game:

1. After the game mode posts the *game_started* event, it will call its *player_turn_start()* method.
2. The *player_turn_start()* method does a few things:
 - (a) If there’s not an active player (because this is the start of a new game), it calls the game mode’s *player_rotate()* method which maps the game’s *player* attribute to the current player.
 - (b) Posts an event called *player_turn_start*.
 - (c) The game mode’s *_player_turn_started()* method is a callback for that event, which is called next.
3. The *_player_turn_started()* method:
 - (a) Increments the ball count for the player
 - (b) Calls the game mode’s *ball_starting()* method.
4. The *ball_starting()* method:
 - (a) Posts player, ball, and score information to the debug log
 - (b) Posts the *ball_starting* event. Like the *game_starting* event from the last step, this is also a queue event, meaning any component can hook in to do whatever it needs to do before releasing control. (This could be per-player animations and cut scenes, maybe the tilt wants to wait a few seconds for the plumb bob to stop rocking, etc.)
5. The game’s *ball_started()* method is the callback for the *ball_starting* event.
 - (a) Event handlers for *ball_drain* are added.
 - (b) *balls_in_play* is set to 1.
 - (c) The *ball_started* event is posted.
6. Many things are configured to respond to the *ball_started* event, including:
 - (a) Shots are enabled
 - (b) Autofire devices are enabled
 - (c) Flippers are enabled
 - (d) Ball lock devices are enabled
 - (e) Multiball devices are enabled

7. The playfield's `add_ball()` method is called.
 - (a) The ball controller looks for a ball device tagged with `ball_add_live`, and it changes that device's desired ball count to 1. (In this example let's assume that you have a plunger lane and a trough.)
 - (b) The trough sees that one of its eject targets (the plunger lane) wants a ball, so it ejects one.
 - (c) The plunger lane receives and confirms that it now has a ball.
 - (d) If this machine has a launch button and a coil-fired plunger, the player hits a button tagged with `player_controlled_eject_tag`.
 - (e) The ball controller receives a request to add a live ball and posts the `ball_add_live` event.
 - (f) The ball device with the `ball_add_live` tag responds by ejecting its ball.
 - (g) When that ball eject is confirmed (based on the settings for that device), the ball controller posts the `ball_live_added` event.
 - (h) If the machine is configured with a `player_controller_eject_tag`, that tag is passed as the trigger event that will launch the ball.

The ball is now in play.

Mode Start Sequence

Here's what happens when a mode starts:

1. One of the events in the mode's `start_events`: is posted.
2. The mode's `start()` method responds since it's registered as a handler for those events.
 - (a) If the mode is currently active, this process ends.
 - (b) If a `callback` kwarg is included in the event, it's saved for later use.
 - (c) Any `kwargs` that were attached to the event which started the mode are saved for later use.
3. Any devices that are configured in this mode's config that are not already created are created now.
4. Any events listed in the mode's `stop_events`: setting are registered and will call the mode's `stop()` method if they're posted.
 - (a) These events are registered with the priority of the mode +1, so they are called first.
5. Any registered mode `start_methods` are called one-by-one. These are called with the mode, the mode's config, and the mode's priority as `kwargs`.
6. Any device `control_events` from the mode config are registered
7. A queue event is posted called `mode_<mode_name>_starting`.
8. The mode's `_started()` method is the callback for the starting queue event and is called when that event is complete.
9. Mode timers are started.
10. An event `mode_<mode_name>_started` is posted.
11. The mode's `_mode_started_callback()` method is the callback for the started event, so it's called once that event is complete.

12. The mode's `mode_start()` method is called. (This is the method that can be subclassed to run custom mode code.)
 - (a) Any *kwargs* that were passed along with the event that started the mode are passed to the `mode_start()` method.
13. If a start *callback* was passed with the event that started the mode, it's called now.

Mode Stop Sequence

Here's what happens behind-the-scenes when a mode stops.

1. An event listed in the mode's `stop_events`: setting is posted.
2. This is handled by the mode's `stop()` method.
 - (a) If the mode is not active, this process ends.
 - (b) If a *callback* argument was passed, it's saved now for later use
 - (c) Other *kwargs* are saved for later use
3. Switch handlers registered by that mode are removed.
4. Timers set in that mode are stopped and removed.
5. Delays set in that mode are cleared.
6. An queue event is posted: `mode_<mode_name>_stopping`.
7. Once that queue is clear, the mode's `_stopped()` method is called.
8. Any mode *stop_methods* registered for that mode are called one-by- one. (mode *stop_methods* are based on anything that gets returned from the call to the mode's *start_methods* when the mode starts).
9. An event `mode_<mode_name>_stopped` is posted.
10. Once any handlers for that event have finished, the mode's `_mode_stopped_callback()` method is called.
11. Mode event handlers are removed.
12. Devices that were created as part of this mode are removed.
13. The mode's `mode_stop()` method is called. (This is the method that can be subclassed in custom mode code for things you want to run when the mode stops.)
 - (a) If *kwargs* were passed as part of the event in Step 1, they're included in the call to `mode_stop()`.
14. If a *callback* was saved in Step 2, it's called now.

Ball End Sequence

This sequence starts with a ball live and in play and ends when the ball drains and the ball is over.

1. The ball enters a ball device device tagged with drain.

2. The ball controller's `_ball_drained_handler()` method responds to the ball having entered a device tagged with `drain`.
3. It posts a relay event called *ball_drain*, along with the number of balls that just drained.
 - (a) Various modules can hook event this to "remove" a ball from the *ball_drain* event so it doesn't count as a drain. (For example, ball save.)
4. The game mode's `ball_drained()` method is registered as a handler for the *ball_drain* event.
5. It subtracts the number of balls that just drained from its *balls_in_play* count.
6. If the *balls_in_play* count was a positive number and goes to zero, the game mode's `ball_ending()` method is called.
7. The game mode posts the queue event *ball_ending*.
8. Once that event is done, the game mode's `_ball_ending_done()` method is called.
9. The event *ball_ended* is posted.
10. The game mode's `ball_ended()` method is called.
 - (a) If the player has any extra balls, the game mode's `shoot_again()` method is called.
 - (b) If the player is the last player, and the ball is the last ball, the game mode's `game_ending()` method is called.
11. Otherwise the game mode's `player_rotate()` method is called.
12. The game mode's `player_turn_start()` method is called.

1. Run diagnosis

If your game won't run, let's make sure MPF is ok. Run `mpf diagnosis` from within your machine folder to see if your installation is fine:

```
$ mpf diagnosis

MPF version: MPF v0.50.0-dev.11
MPF install location: /data/home/jan/cloud/flipper/src/mpf/mpf
Machine folder detected: /data/home/jan/cloud/flipper/src/good_vs_evil
MPF-MC version: MPF-MC v0.50.0-dev.5 (config_version=5, BCP v1.1, Requires MPF v0.50.0-dev.10)

Serial ports found:
/dev/ttyUSB3
  desc: Quad RS232-HS
  hwid: USB VID:PID=0403:6011 LOCATION=1-12
/dev/ttyUSB2
  desc: Quad RS232-HS
  hwid: USB VID:PID=0403:6011 LOCATION=1-12
/dev/ttyUSB1
  desc: Quad RS232-HS
  hwid: USB VID:PID=0403:6011 LOCATION=1-12
/dev/ttyUSB0
  desc: Quad RS232-HS
  hwid: USB VID:PID=0403:6011 LOCATION=1-12
```

If you suspect a problem with MPF itself you can try to run the `demo_man` game. Make sure that you select the same version as your MPF version (i.e. `demo_man 0.33.x` for MPF 0.33.10).

Additionally, you can run the MPF and MPF-MC unit tests (the number of tests may be different).


```
$ python3 -m unittest discover -s mpf.tests  
[...]
```

```
-----  
Ran 622 tests in 20.818s
```

```
OK
```

Similarly, you can run MPF-MC unit tests (they will take a bit longer and might show some deprecation warnings from kivy):

```
$ python3 -m unittest discover -s mpfmc.tests  
[...]
```

```
Ran 182 tests in 193.610s
```

```
OK
```

2. Ask in our forum

If you cannot solve the problem ask in our [support forum](#). Please include the following information:

1. The output of `mpf diagnosis`
2. In case you suspect an installation problem include the output of unittests and if you can run `demo_man`.
3. Add a log of your game. Therefore, run your game with `mpf` both `-v` `-V` and grab the latest MPF and MC log from the log folder in your machine.
4. Describe how to reproduce your problem.
5. Provide relevant config snippets or, if possible, a link to download/checkout your machine config so we can reproduce the issue.

Example Configuration Files

MPF is very complex with lots of modules and options. In order to make sure that everything works, we have over 700 automated tests that run every time we add or change something in MPF in order to make sure we didn't break something.

All of these automated tests include config files (machine configs, mode configs, and show files). In many ways, these config files are the “ultimate truth” when it comes to what configs actually work with MPF.

All of the links below show the actual config files (pulled from the MPF and MPF-MC packages) that are used to test MPF. They're also a valuable resource for people creating games with MPF since they show many different options and configurations that are known to work.

You can click on any of the links below to see the actual config files for each topic. Each link may have multiple separate machine configs, mode configs, and/or show configs.

accelerometer (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.1: `your_machine_folder/config/config.yaml`

```
#config_version=4

accelerometers:
  test_accelerometer:
    number: 1
    level_x: 0
    level_y: 0
```



```
level_z: 1
hit_limits:
  0.5: event_hit1
  1.5: event_hit2
level_limits:
  2: event_level1
  5: event_level2
```

achievement (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.2: `your_machine_folder/config/config.yaml`

```
#config_version=4

switches:
  test:
    number:

leds:
  led1:
    number:
  led2:
    number:
  led4:
    number:
  led5:
    number:
  led6:
    number:

modes:
  - base

shows:
  achievement1_enabled:
    - time: 1
  achievement1_started:
    - time: 1
  achievement1_completed:
    - time: 1
  achievement1_disabled:
    - time: 1
  achievement1_stopped:
    - time: 1

  achievement2_disabled:
    - time: 1
  leds:
```



```
(led): off
achievement2_enabled:
- time: 1
  leds:
    (led): yellow
achievement2_started:
- time: 1
  leds:
    (led): green
achievement2_stopped:
- time: 1
  leds:
    (led): red
achievement2_completed:
- time: 1
  leds:
    (led): blue
```

Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Listing 22.3: `your_machine_folder/modes/base/config/base.yaml`

```
#config_version=4
mode:
  start_events: ball_starting
  priority: 100

achievements:
  achievement1:
    start_events: achievement1_start
    stop_events: achievement1_stop
    enable_events: achievement1_enable
    disable_events: achievement1_disable
    complete_events: achievement1_complete
    reset_events: achievement1_reset
    show_when_disabled: achievement1_disabled
    show_when_enabled: achievement1_enabled
    show_when_started: achievement1_started
    show_when_stopped: achievement1_stopped
    show_when_completed: achievement1_completed
    restart_on_next_ball_when_started: True

  achievement2:
    start_events: achievement2_start
    stop_events: achievement2_stop
    enable_events: achievement2_enable
    disable_events: achievement2_disable
    complete_events: achievement2_complete
    reset_events: achievement2_reset
    events_when_started: test_event, test_event2
    show_when_enabled: achievement2_enabled
    show_when_started: achievement2_started
```



```
show_when_completed: achievement2_completed
restart_after_stop_possible: False
enable_on_next_ball_when_enabled: False
show_tokens:
    led: led1

achievement3:
    start_events: achievement3_start
    stop_events: achievement3_stop
    enable_events: achievement3_enable
    disable_events: achievement3_disable
    complete_events: achievement3_complete
    reset_events: achievement3_reset
    events_when_started: test_event, test_event3
    show_when_disabled: achievement_disabled
    show_when_enabled: achievement_enabled
    show_when_started: achievement_started
    show_when_stopped: achievement_stopped
    show_when_completed: achievement_completed
    restart_after_stop_possible: False

achievement4:
    start_events: achievement4_start
    stop_events: achievement4_stop
    enable_events: achievement4_enable
    disable_events: achievement4_disable
    complete_events: achievement4_complete
    reset_events: achievement4_reset
    show_when_disabled: achievement_disabled
    show_when_enabled: achievement_enabled
    show_when_started: achievement_started
    show_when_stopped: achievement_stopped
    show_when_completed: achievement_completed
    show_when_selected: achievement_selected
    show_tokens:
        led: led4

achievement5:
    start_events: achievement5_start
    stop_events: achievement5_stop
    enable_events: achievement5_enable
    disable_events: achievement5_disable
    complete_events: achievement5_complete
    reset_events: achievement5_reset
    events_when_started: test_event, test_event5
    show_when_disabled: achievement_disabled
    show_when_enabled: achievement_enabled
    show_when_started: achievement_started
    show_when_stopped: achievement_stopped
    show_when_completed: achievement_completed
    show_when_selected: achievement_selected
    show_tokens:
        led: led5

achievement6:
```



```
start_events: achievement6_start
stop_events: achievement6_stop
enable_events: achievement6_enable
disable_events: achievement6_disable
complete_events: achievement6_complete
reset_events: achievement6_reset
events_when_started: test_event, test_event6
show_when_disabled: achievement_disabled
show_when_enabled: achievement_enabled
show_when_started: achievement_started
show_when_stopped: achievement_stopped
show_when_completed: achievement_completed
show_when_selected: achievement_selected
show_tokens:
    led: led6

achievement7: {}

achievement8: {}

achievement9: {}

achievement10: {}

achievement11: {}

achievement12:
    enable_events: enable_achievements

achievement13:
    enable_events: enable_achievements

achievement_groups:
    group1:
        achievements: achievement7, achievement8, achievement9
        auto_select: true

    group2:
        achievements: achievement4, achievement5, achievement6
        enable_events: group2_enable
        disable_events: group2_disable
        start_selected_events: group2_start
        select_random_achievement_events: group2_random
        rotate_right_events: group2_rotate_right
        rotate_left_events: group2_rotate_left

        disable_while_achievement_started: False
        enable_while_no_achievement_started: False

        events_when_all_completed: group2_complete
        events_when_no_more_enabled: group2_no_more
        events_when_enabled: group2_enabled

        show_when_enabled: group2_show
        show_tokens:
```



```
    led: led2

    group3:
      achievements:
        achievement10
        achievement11
        achievement12
        achievement13
      auto_select: yes

shows:
  group2_show:
    - duration: .1
      leds:
        (led): red
    - duration: .1
      leds:
        (led): blue
  achievement_enabled:
    - duration: 1
      leds:
        (led): yellow
  achievement_disabled:
    - duration: 1
      leds:
        (led): off
  achievement_completed:
    - duration: 1
      leds:
        (led): blue
  achievement_started:
    - duration: 1
      leds:
        (led): green
  achievement_stopped:
    - duration: 1
      leds:
        (led): red
  achievement_selected:
    - duration: 1
      leds:
        (led): orange
```

animated_images (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.4: `your_machine_folder/config/test_animated_images.yaml`

```
#config_version=4

displays:
  default:
    width: 400
    height: 300

slides:
  slide1:
    - type: image
      image: ball
      y: 250
      fps: 30
    - image: busy-stick-figures-animated
      type: image
      y: 100
#    auto_play: no
    x: 250
    - type: text
      text: ZIP FILE OF PNGs
      y: 260
    - type: text
      text: ANIMATED GIF
      x: 10
      y: 100
      anchor_x: left
    - type: text
      text: (ALSO TESTING STOPPING
      x: 10
      y: 80
      font_size: 10
      anchor_x: left
    - type: text
      text: SKIPPING, & STARTING)
      font_size: 10
      x: 14
      y: 68
      anchor_x: left
slide_player:
  slide1: slide1
```

animation (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.5: `your_machine_folder/config/test_animation.yaml`

```
#config_version=4

displays:
  default:
    width: 400
    height: 300

slides:
  slide1:
    type: text
    text: text
    x: 0
    animations:
      show_slide:
        - property: x # x, y, height, width, opacity, rotation?
          value: 101
          duration: 1s
          repeat: -1
        - property: x # x, y, height, width, opacity, rotation?
          value: 100
          duration: 1s
          timing: with_previous # or after prev
          repeat: True
    reset_animations_events: pre_show_slide

  slide2:
    type: text
    text: ANIMATION TEST
    color: ff00ff
    font_size: 100
    y: 300
    x: 400
    animations:
      entrance2:
        property: x, y
        value: 0, 0
        duration: 1s
        timing: with_previous # or after prev
        repeat: True

  slide3:
    type: text
    text: text3
    color: green
    opacity: 0
    animations:
      entrance3: fade_in, multi

  slide4:
    type: text
    text: text4
    animations:
      entrance4: fade_in, multi
```



```
    some_event4: multi

slide5:
  type: text
  text: text5
  animations:
    entrance5: fade_in, multi
    event5:
      property: x # x, y, height, width, opacity, rotation?
      value: 98
      duration: 1s
      timing: with_previous # or after prev
      repeat: True

slide6:
  type: text
  text: text6

slide7:
  type: text
  text: TEST ANIMATION ON show_slide
  x: 0
  color: ffaa00
  font_size: 50
  animations:
    show_slide:
      property: x
      value: 400
      duration: 500ms

slide8:
  type: text
  text: TEST ANIMATION FROM OFF SCREEN
  y: 75%

base_slide:
  background_color: blue
  widgets:
    type: text
    text: WIDGET ANIMATION TESTS

slide9:
  type: text
  text: ANIMATION pre_show_slide
  x: 0
  color: ffaa00
  font_size: 50
  animations:
    pre_show_slide:
      property: x
      value: 400
      duration: 500ms

slide10:
  type: text
```



```
text: ANIMATION show_slide
x: 0
color: ffaa00
font_size: 50
animations:
  show_slide:
    property: x
    value: 400
    duration: 500ms

slide11:
  type: text
  text: ANIMATION pre_slide_leave
  color: ffaa00
  font_size: 50
  animations:
    pre_slide_leave:
      property: x
      value: -400
      duration: 500ms

slide12:
  type: text
  text: ANIMATION slide_leave
  color: ffaa00
  font_size: 50
  animations:
    slide_leave:
      property: x
      value: 0
      duration: 500ms

slide13:
  type: text
  text: RESET POSITION pre_show_slide
  x: 0
  animations:
    show_slide:
      - property: x
        value: 100
        duration: 1s
  reset_animations_events: pre_show_slide

slide14:
  type: text
  text: RESET POSITION slide_play
  x: 0
  animations:
    show_slide:
      - property: x
        value: 100
        duration: 1s
  reset_animations_events: slide_play

slide15:
```



```
type: text
text: RESET POSITION standard event
x: 0
animations:
  show_slide:
    - property: x
      value: 100
      duration: 1s
  reset_animations_events: event1

slide_player:
  show_slide1: slide1
  show_slide7: slide7
  show_slide2: slide2
  show_slide3: slide3
  show_slide8: slide8
  show_slide9:
    slide9:
      transition:
        type: fade
        duration: 1s
  show_slide10:
    slide10:
      transition:
        type: fade
        duration: 1s
  show_slide11: slide11
  show_slide12: slide12
  show_base_slide: base_slide
  show_base_slide_with_transition:
    base_slide:
      transition:
        type: fade
        duration: 1s
  show_slide13: slide13
  show_slide14: slide14
  show_slide15: slide15

widgets:
  widget1:
    type: text
    text: WIDGET 1
    color: red
    x: -100
    animations:
      move_on_slide:
        - property: x
          value: 100
          duration: 500ms
          timing: after_previous
      move_off_slide:
        - property: x
          value: -100
          duration: 500ms
          timing: after_previous
```



```
    expire: 2s

widget2:
  type: text
  text: widget2
  color: red
  opacity: 0
  animations:
    animate_widget2: fade_in, multi
    pulse_widget2: pulse, pulse, pulse, pulse

widget_player:
  show_widget1: widget1
  show_widget2: widget2

animations:
  fade_in:
    property: opacity
    value: 1
    duration: 1s
    timing: with_previous
    repeat: True

  multi:
    - property: y
      value: 0
      duration: 1s
    - property: x
      value: 0%
      duration: 100ms
      timing: after_previous
      repeat: False

  pulse:
    - property: opacity
      value: 0
      duration: 100ms
    - property: opacity
      value: 1
      duration: 100ms
      timing: after_previous
```

asset_manager (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.6: your_machine_folder/config/test_asset_loading.yaml

```
#config_version=4

mpf:
  default_matrix_light_hw_update_hz: 1
  default_led_hw_update_hz: 1

leds:
  led_01:
    number: 0
  led_02:
    number: 1

matrix_lights:
  light_01:
    number: 0
    label: Test 0
  light_02:
    number: 1
    label: Test 1

gis:
  gi_01:
    number: 0

coils:
  coil_01:
    number: 1
    pulse_ms: 30

flashers:
  flasher_01:
    number: 1
    label: Test flasher
    flash_ms: 40

modes:
  - mode1

assets:
  file_shows:
    default:
      load: preload
    preload:
      load: preload
      test_key: test_value
    on_demand:
      load: on_demand
    mode_start:
      load: mode_start

file_shows:
  show_12_new_name:
    file: show12.yaml
```



```
    test_key: test_value_override12
show_13_new_name:
  file: show13.yaml
show3:
  test_key: test_value_override3

show_pools:
  group1:
    load: preload
    shows:
      - show1
      - show2
      - show3
    type: random
  group2:
    load: preload
    shows:
      - show1
      - show2
      - show3|2
    type: random
  group3:
    shows:
      - show1
      - show2
      - show3
    type: sequence
  group4:
    shows:
      - show1|4
      - show2|2
      - show3
    type: sequence
  group5:
    shows:
      - show1|1
      - show2|5
      - show3|1
    type: random_force_next
  group6:
    shows:
      - show1
      - show2
      - show3
    type: random_force_all
```

Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Note that there are multiple mode config examples here. You might not necessarily use more than one in your machine.

Listing 22.7: `your_machine_folder/modes/model1/config/model1.yaml`

```
#config_version=4

mode:
  priority: 300
  game_mode: False
```

Listing 22.8: `your_machine_folder/modes/model1/shows/show6.yaml`

```
# show_version=4
- time: 0
  leds:
    led_01: 006400
    led_02: CCCCCC
  lights:
    light_01: CC
    light_02: 78
  gis:
    gi_01: FF
- time: 1
  leds:
    led_01: DarkGreen
    led_02: Black
- time: 2
  leds:
    led_01: DarkSlateGray
    led_02: Tomato
  lights:
    light_01: FF
    light_02: 33
  gis:
    gi_01: 99
- time: +1
  leds:
    led_01: MidnightBlue-f500 ms
    led_02: DarkOrange-f0.5 s
  gis:
    gi_01: 33
- time: 4
  leds:
    led_01: Off-f800
    led_02: Off-f800
  lights:
    light_01: 00-f800
    light_02: 00-f800
  gis:
    gi_01: 00
- time: 6
```

Listing 22.9: `your_machine_folder/modes/model1/shows/custom1/show8.yaml`

```
# show_version=4
- time: 0
  leds:
```



```

    led_01: 006400
    led_02: CCCCCC
lights:
  light_01: CC
  light_02: 78
gis:
  gi_01: FF
- time: 1
  leds:
    led_01: DarkGreen
    led_02: Black
- time: 2
  leds:
    led_01: DarkSlateGray
    led_02: Tomato
  lights:
    light_01: FF
    light_02: 33
  gis:
    gi_01: 99
- time: +1
  leds:
    led_01: MidnightBlue-f500 ms
    led_02: DarkOrange-f0.5 s
  gis:
    gi_01: 33
- time: 4
  leds:
    led_01: Off-f800
    led_02: Off-f800
  lights:
    light_01: 00-f800
    light_02: 00-f800
  gis:
    gi_01: 00
- time: 6

```

Listing 22.10: `your_machine_folder/modes/mode1/shows/mode_start/show9.yaml`

```

# show_version=4
- time: 0
  leds:
    led_01: 006400
    led_02: CCCCCC
  lights:
    light_01: CC
    light_02: 78
  gis:
    gi_01: FF
- time: 1
  leds:
    led_01: DarkGreen
    led_02: Black
- time: 2
  leds:

```



```

    led_01: DarkSlateGray
    led_02: Tomato
lights:
    light_01: FF
    light_02: 33
gis:
    gi_01: 99
- time: +1
  leds:
    led_01: MidnightBlue-f500 ms
    led_02: DarkOrange-f0.5 s
  gis:
    gi_01: 33
- time: 4
  leds:
    led_01: Off-f800
    led_02: Off-f800
  lights:
    light_01: 00-f800
    light_02: 00-f800
  gis:
    gi_01: 00
- time: 6

```

Listing 22.11: `your_machine_folder/modes/model/shows/on_demand/show10.yaml`

```

# show_version=4
- time: 0
  leds:
    led_01: 006400
    led_02: CCCCCC
  lights:
    light_01: CC
    light_02: 78
  gis:
    gi_01: FF
- time: 1
  leds:
    led_01: DarkGreen
    led_02: Black
- time: 2
  leds:
    led_01: DarkSlateGray
    led_02: Tomato
  lights:
    light_01: FF
    light_02: 33
  gis:
    gi_01: 99
- time: +1
  leds:
    led_01: MidnightBlue-f500 ms
    led_02: DarkOrange-f0.5 s
  gis:
    gi_01: 33

```



```
- time: 4
  leds:
    led_01: Off-f800
    led_02: Off-f800
  lights:
    light_01: 00-f800
    light_02: 00-f800
  gis:
    gi_01: 00
- time: 6
```

Listing 22.12: `your_machine_folder/modes/model1/shows/preload/show7.yaml`

```
# show_version=4
- time: 0
  leds:
    led_01: 006400
    led_02: CCCCCC
  lights:
    light_01: CC
    light_02: 78
  gis:
    gi_01: FF
- time: 1
  leds:
    led_01: DarkGreen
    led_02: Black
- time: 2
  leds:
    led_01: DarkSlateGray
    led_02: Tomato
  lights:
    light_01: FF
    light_02: 33
  gis:
    gi_01: 99
- time: +1
  leds:
    led_01: MidnightBlue-f500 ms
    led_02: DarkOrange-f0.5 s
  gis:
    gi_01: 33
- time: 4
  leds:
    led_01: Off-f800
    led_02: Off-f800
  lights:
    light_01: 00-f800
    light_02: 00-f800
  gis:
    gi_01: 00
- time: 6
```


Show file examples

Here are some example show files that go along with the above config(s).

Note that there are multiple shows here.

Listing 22.13: `your_machine_folder/shows/show1.yaml`

```
# show_version=4
- time: 0
  leds:
    led_01: 006400
    led_02: CCCCCC
  lights:
    light_01: CC
    light_02: 78
  gis:
    gi_01: FF
- time: 1
  leds:
    led_01: DarkGreen
    led_02: Black
- time: 2
  leds:
    led_01: DarkSlateGray
    led_02: Tomato
  lights:
    light_01: FF
    light_02: 33
  gis:
    gi_01: 99
- time: +1
  leds:
    led_01: MidnightBlue-f500 ms
    led_02: DarkOrange-f0.5 s
  gis:
    gi_01: 33
- time: 4
  leds:
    led_01: Off-f800
    led_02: Off-f800
  lights:
    light_01: 00-f800
    light_02: 00-f800
  gis:
    gi_01: 00
- time: 6
```

Listing 22.14: `your_machine_folder/shows/show12.yaml`

```
# show_version=4
- time: 0
  leds:
    led_01: 006400
    led_02: CCCCCC
  lights:
```



```

    light_01: CC
    light_02: 78
  gis:
    gi_01: FF
- time: 1
  leds:
    led_01: DarkGreen
    led_02: Black
- time: 2
  leds:
    led_01: DarkSlateGray
    led_02: Tomato
  lights:
    light_01: FF
    light_02: 33
  gis:
    gi_01: 99
- time: +1
  leds:
    led_01: MidnightBlue-f500 ms
    led_02: DarkOrange-f0.5 s
  gis:
    gi_01: 33
- time: 4
  leds:
    led_01: Off-f800
    led_02: Off-f800
  lights:
    light_01: 00-f800
    light_02: 00-f800
  gis:
    gi_01: 00
- time: 6

```

Listing 22.15: `your_machine_folder/shows/show2.yaml`

```

# show_version=4
- time: 0
  leds:
    led_01: 006400
    led_02: CCCCCC
  lights:
    light_01: CC
    light_02: 78
  gis:
    gi_01: FF
- time: 1
  leds:
    led_01: DarkGreen
    led_02: Black
- time: 2
  leds:
    led_01: DarkSlateGray
    led_02: Tomato
  lights:

```



```
    light_01: FF
    light_02: 33
  gis:
    gi_01: 99
- time: +1
  leds:
    led_01: MidnightBlue-f500 ms
    led_02: DarkOrange-f0.5 s
  gis:
    gi_01: 33
- time: 4
  leds:
    led_01: Off-f800
    led_02: Off-f800
  lights:
    light_01: 00-f800
    light_02: 00-f800
  gis:
    gi_01: 00
- time: 6
```

Listing 22.16: `your_machine_folder/shows/show3.yaml`

```
# show_version=4
- time: 0
  leds:
    led_01: 006400
    led_02: CCCCCC
  lights:
    light_01: CC
    light_02: 78
  gis:
    gi_01: FF
- time: 1
  leds:
    led_01: DarkGreen
    led_02: Black
- time: 2
  leds:
    led_01: DarkSlateGray
    led_02: Tomato
  lights:
    light_01: FF
    light_02: 33
  gis:
    gi_01: 99
- time: +1
  leds:
    led_01: MidnightBlue-f500 ms
    led_02: DarkOrange-f0.5 s
  gis:
    gi_01: 33
- time: 4
  leds:
    led_01: Off-f800
```



```
    led_02: Off-f800
  lights:
    light_01: 00-f800
    light_02: 00-f800
  gis:
    gi_01: 00
- time: 6
```

Listing 22.17: your_machine_folder/shows/custom1/show11.yaml

```
# show_version=4
- time: 0
  leds:
    led_01: 006400
    led_02: CCCCCC
  lights:
    light_01: CC
    light_02: 78
  gis:
    gi_01: FF
- time: 1
  leds:
    led_01: DarkGreen
    led_02: Black
- time: 2
  leds:
    led_01: DarkSlateGray
    led_02: Tomato
  lights:
    light_01: FF
    light_02: 33
  gis:
    gi_01: 99
- time: +1
  leds:
    led_01: MidnightBlue-f500 ms
    led_02: DarkOrange-f0.5 s
  gis:
    gi_01: 33
- time: 4
  leds:
    led_01: Off-f800
    led_02: Off-f800
  lights:
    light_01: 00-f800
    light_02: 00-f800
  gis:
    gi_01: 00
- time: 6
```

Listing 22.18: your_machine_folder/shows/custom1/show13.yaml

```
# show_version=4
- time: 0
  leds:
```



```

    led_01: 006400
    led_02: CCCCCC
lights:
  light_01: CC
  light_02: 78
gis:
  gi_01: FF
- time: 1
  leds:
    led_01: DarkGreen
    led_02: Black
- time: 2
  leds:
    led_01: DarkSlateGray
    led_02: Tomato
  lights:
    light_01: FF
    light_02: 33
  gis:
    gi_01: 99
- time: +1
  leds:
    led_01: MidnightBlue-f500 ms
    led_02: DarkOrange-f0.5 s
  gis:
    gi_01: 33
- time: 4
  leds:
    led_01: Off-f800
    led_02: Off-f800
  lights:
    light_01: 00-f800
    light_02: 00-f800
  gis:
    gi_01: 00
- time: 6

```

Listing 22.19: `your_machine_folder/shows/on_demand/show5.yaml`

```

# show_version=4
- time: 0
  leds:
    led_01: 006400
    led_02: CCCCCC
  lights:
    light_01: CC
    light_02: 78
  gis:
    gi_01: FF
- time: 1
  leds:
    led_01: DarkGreen
    led_02: Black
- time: 2
  leds:

```



```

    led_01: DarkSlateGray
    led_02: Tomato
lights:
  light_01: FF
  light_02: 33
gis:
  gi_01: 99
- time: +1
  leds:
    led_01: MidnightBlue-f500 ms
    led_02: DarkOrange-f0.5 s
  gis:
    gi_01: 33
- time: 4
  leds:
    led_01: Off-f800
    led_02: Off-f800
  lights:
    light_01: 00-f800
    light_02: 00-f800
  gis:
    gi_01: 00
- time: 6

```

Listing 22.20: `your_machine_folder/shows/preload/show4.yaml`

```

# show_version=4
- time: 0
  leds:
    led_01: 006400
    led_02: CCCCCC
  lights:
    light_01: CC
    light_02: 78
  gis:
    gi_01: FF
- time: 1
  leds:
    led_01: DarkGreen
    led_02: Black
- time: 2
  leds:
    led_01: DarkSlateGray
    led_02: Tomato
  lights:
    light_01: FF
    light_02: 33
  gis:
    gi_01: 99
- time: +1
  leds:
    led_01: MidnightBlue-f500 ms
    led_02: DarkOrange-f0.5 s
  gis:
    gi_01: 33

```



```
- time: 4
  leds:
    led_01: Off-f800
    led_02: Off-f800
  lights:
    light_01: 00-f800
    light_02: 00-f800
  gis:
    gi_01: 00
- time: 6
```

Listing 22.21: `your_machine_folder/shows/preload/subfolder/show4b.yaml`

```
# show_version=4
- time: 0
  leds:
    led_01: 006400
    led_02: CCCCCC
  lights:
    light_01: CC
    light_02: 78
  gis:
    gi_01: FF
- time: 1
  leds:
    led_01: DarkGreen
    led_02: Black
- time: 2
  leds:
    led_01: DarkSlateGray
    led_02: Tomato
  lights:
    light_01: FF
    light_02: 33
  gis:
    gi_01: 99
- time: +1
  leds:
    led_01: MidnightBlue-f500 ms
    led_02: DarkOrange-f0.5 s
  gis:
    gi_01: 33
- time: 4
  leds:
    led_01: Off-f800
    led_02: Off-f800
  lights:
    light_01: 00-f800
    light_02: 00-f800
  gis:
    gi_01: 00
- time: 6
```


assets_and_image (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Note that there are multiple machine config examples here. They're just included to show different options. You wouldn't actually use more than one.

Listing 22.22: `your_machine_folder/config/test_asset_loading.yaml`

```
#config_version=4

modes:
  - mode1

assets:
  images:
    default:
      load: preload
    preload:
      load: preload
      test_key: test_value
    on_demand:
      load: on_demand
    mode_start:
      load: mode_start

images:
  image_12_new_name:
    file: image12.png
    test_key: test_value_override12
  image_13_new_name:
    file: image13.png
  image3:
    test_key: test_value_override3

image_pools:
  group1:
    load: preload
    images:
      - image1
      - image2
      - image3
    type: random
  group2:
    load: preload
    images:
      - image1
      - image2
      - image3|2
    type: random
  group3:
    images:
```



```
- image1
- image2
- image3
  type: sequence
group4:
  images:
    - image1|4
    - image2|2
    - image3
    type: sequence
group5:
  images:
    - image1|1
    - image2|5
    - image3|1
    type: random_force_next
group6:
  images:
    - image1
    - image2
    - image3
  type: random_force_all
```

Listing 22.23: `your_machine_folder/config/test_image.yaml`

```
#config_version=4

modes:
- mode1

displays:
  default:
    width: 400
    height: 300

slides:
  image_test:
    - type: image
      image: image1
      x: 50
    - type: image
      image: image2
      x: 80
    - type: image
      image: image3
      x: 110
    - type: image
      image: image4
      x: 140
    - type: image
      image: image5
      x: 170
    - type: image
      image: image6
      x: 200
```



```
- type: image
  image: image7
  x: 230
- type: image
  image: image8
  x: 260
- type: image
  image: image9
  x: 290
- type: image
  image: image10
  x: 320
- type: image
  image: image11
  x: 350
- type: image
  image: image12
  x: 380

slide_player:
  show_slide1: image_test

assets:
  images:
    default:
      load: preload
    preload:
      load: preload
      test_key: test_value
    on_demand:
      load: on_demand
    mode_start:
      load: mode_start
```

Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Listing 22.24: `your_machine_folder/modes/mode1/config/mode1.yaml`

```
#config_version=4

mode:
  priority: 300

images:
  image6:
    file: image6.png
    load: mode_start
```

audio (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Note that there are multiple machine config examples here. They're just included to show different options. You wouldn't actually use more than one.

Listing 22.25: `your_machine_folder/config/test_audio.yaml`

```
#config_version=4
sound_system:
  buffer: 2048
  frequency: 44100
  channels: 2
  master_volume: 0.9
  tracks:
    music:
      volume: 0.5
      simultaneous_sounds: 1
      events_when_stopped: music_track_stopped
      events_when_played: music_track_played, keep_going
      events_when_paused: music_track_paused
    sfx:
      volume: 0.4
      simultaneous_sounds: 8
      preload: yes
    voice:
      volume: 0.6
      simultaneous_sounds: 1
      preload: yes

modes:
- mode1
- mode2

assets:
  sounds:
    default:
```



```

        load: preload
    voice:
        load: preload
        track: voice
    sfx:
        load: preload
        track: sfx
    music:
        load: on_demand
        track: music

sounds:
    264828_text:
        events_when_played: text_sound_played
        events_when_looping: text_sound_looping
        events_when_stopped: text_sound_stopped
        loops: 7
        simultaneous_limit: 3
        stealing_method: skip
    104457_moron_test:
        streaming: False
        events_when_played: moron_test_played
        events_when_stopped: moron_test_stopped
        volume: 0.6
        ducking:
            target: music
            delay: 0
            attack: 1.0sec
            attenuation: -18db
            release_point: 3sec
            release: 2.25sec
        markers:
            - time: 2.5sec
              events: moron_marker
            - time: 3.5sec
              name: verse_1
              events: moron_next_marker, last_marker
    210871_synthping:
        simultaneous_limit: 3
        stealing_method: oldest
        events_when_played: synthping_played
    198361_sfx-028:
        simultaneous_limit: 3
        stealing_method: newest
    263774_music:
        streaming: False

sound_pools:
    drum_group:
        load: preload
        type: sequence
        simultaneous_limit: 3
        stealing_method: skip
        sounds:
            - 4832__zajo__drum07

```



```

- 84480__zgump__drum-fx-4
- 100184__menegass__rick-drum-bd-hard

sound_player:
  load_music:
    263774_music:
      action: load
  unload_music:
    263774_music:
      action: unload
  play_sound_synthping: 210871_synthping
  play_sound_text:
    264828_text:
      loops: -1
      priority: 100
  stop_sound_looping_text:
    264828_text:
      action: stop_looping
  play_sound_moron_test: 104457_moron_test
  stop_sound_moron_test:
    104457_moron_test:
      action: stop
  play_sound_test:
    113690_test:
      volume: 0.25
  play_sound_music:
    263774_music:
      volume: 0.5
  stop_sound_music:
    263774_music:
      action: stop
  play_sound_drum_group: drum_group
  play_sound_text_default_params: 264828_text
  play_sound_text_param_set_1:
    264828_text:
      volume: 0.67
      loops: 2
      priority: 1000
      start_at: 0.05s
      fade_in: 0.25s
      fade_out: 0.1s
      max_queue_time: 0.15s
      events_when_played: text_sound_played_param_set_1
      events_when_stopped: text_sound_stopped_param_set_1
      events_when_looping: text_sound_looping_param_set_1

track_player:
  stop_all_tracks:
    __all__:
      action: stop
      fade: 1.5 sec
  stop_music_track:
    music:
      action: stop
      fade: 1.5 sec

```



```

play_music_track:
  music:
    action: play
    fade: 1.5 sec
pause_music_track:
  music:
    action: pause
resume_music_track:
  music:
    action: play
set_music_track_volume_loud:
  music:
    action: set_volume
    volume: 0.95
    fade: 0.5 sec
set_music_track_volume_quiet:
  music:
    action: set_volume
    volume: 0.3
    fade: 0.5 sec
stop_all_sounds_on_music_track:
  music:
    action: stop_all_sounds
    fade: 0.5 sec
stop_all_sounds:
  __all__:
    action: stop_all_sounds

```

Listing 22.26: `your_machine_folder/config/test_audio_bad_buffer_setting.yaml`

```

#config_version=4
sound_system:
  buffer: 1000 # Not a power of two as required
  tracks:
    voice:
      volume: 0.6
      simultaneous_sounds: 1
      preload: yes
    sfx:
      volume: 0.4
      simultaneous_sounds: 8
      preload: yes
    music:
      volume: 0.5
      simultaneous_sounds: 1
  modes:
    - mode1
  assets:
    sounds:
      default:
        load: preload
      voice:
        load: preload

```



```
    track: voice
  sfx:
    load: on_demand
    track: sfx
  music:
    load: on_demand
    track: music
```

Listing 22.27: `your_machine_folder/config/test_audio_default_settings.yaml`

```
#config_version=4

# No sound_system section, default settings should be used

modes:
- mode1

assets:
  sounds:
    default:
      load: preload
  voice:
    load: preload
    track: default
  sfx:
    load: on_demand
    track: default
  music:
    load: on_demand
    track: default
```

Listing 22.28: `your_machine_folder/config/test_audio_disabled.yaml`

```
#config_version=4
sound_system:
  enabled: False

modes:
- mode1
```

Listing 22.29: `your_machine_folder/config/test_audio_gstreamer.yaml`

```
#config_version=4
displays:
  default:
    width: 400
    height: 300

sound_system:
  buffer: 2048
  frequency: 44100
  channels: 2
  master_volume: 0.9
  tracks:
    music:
```



```
    volume: 0.5
    simultaneous_sounds: 1
sfx:
    volume: 0.3
    simultaneous_sounds: 8
voice:
    volume: 0.6
    simultaneous_sounds: 1

assets:
  sounds:
    default:
      load: preload
    voice:
      load: preload
      track: voice
    sfx:
      load: on_demand
      track: sfx
    music:
      load: on_demand
      track: music
  videos:
    default:
      load: preload
    preload:
      load: preload
    on_demand:
      load: on_demand
    mode_start:
      load: mode_start

sounds:
  264828_text:
    volume: 0.1
    events_when_played: text_sound_played
    events_when_looping: text_sound_looping
    events_when_stopped: text_sound_stopped
    loops: 6
    simultaneous_limit: 3
    stealing_method: skip

  210871_synthping:
    simultaneous_limit: 3
    stealing_method: oldest
    events_when_played: synthping_played

  198361_sfx-028:
    volume: 0.25

  263774_music:
    volume: 0.4

  city_loop:
    file: 223093__qubodup__seamless-city-loop.flac
```



```

    streaming: True
    volume: 0.15
    fade_in: 2.0 sec

sound_player:
  play_sound_text: 264828_text
  play_sound_synthping: 210871_synthping
  play_sound_sfx_028: 198361_sfx-028
  play_city_loop: city_loop

slides:
  video_test:
    - type: video
      video: mpf_video_small_test
    - type: text
      text: Sound and Video Test
      y: bottom+20%
    - type: text
      text: ""
      y: bottom+10%

slide_player:
  show_slide1: video_test

videos:
  mpf_video_small_test:
    width: 100
    height: 70

```

Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Note that there are multiple mode config examples here. You might not necessarily use more than one in your machine.

Listing 22.30: `your_machine_folder/modes/mode1/config/mode1.yaml`

```

# config_version=4

mode:
  priority: 500

sound_player:
  play_sound_synthping_in_mode: 210871_synthping
  play_sound_drum_group_in_mode: drum_group

```

Listing 22.31: `your_machine_folder/modes/mode2/config/mode2.yaml`

```

# config_version=4

mode:
  priority: 500

```



```
sounds:
  boing_mode2:
    file: 140867__juskiddink__boing.wav
    events_when_played: boing_sound_played

sound_player:
  play_sound_boing_in_mode2: boing_mode2
  play_sound_music_fade_at_mode_end:
    263774_music:
      volume: 0.8
      mode_end_action: stop
      fade_out: 1s
```

auditor (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.32: `your_machine_folder/config/config.yaml`

```
#config_version=4

game:
  balls_per_game: 1

switches:
  s_test:
    number:
  s_start:
    number:
    tags: start
  s_ball:
    number:

coils:
  c_eject:
    number:

ball_devices:
  s_trough:
    ball_switches: s_ball
    eject_coil: c_eject
    tags: trough, drain, home, ball_add_live
```


autofire (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.33: [your_machine_folder/config/config.yaml](#)

```
#config_version=4

switches:
  s_test:
    number: 7
  s_test_nc:
    number: 1A
    type: 'NC'

coils:
  c_test:
    number: 4
    pulse_ms: 23
  c_test2:
    number: 5
    pulse_ms: 23

autofire_coils:
  ac_test:
    coil: c_test
    switch: s_test
  ac_test_inverted:
    coil: c_test2
    switch: s_test_nc
  ac_test_inverted2:
    coil: c_test2
    switch: s_test
    reverse_switch: True
```

ball_controller (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.34: [your_machine_folder/config/config.yaml](#)

```
#config_version=4

game:
  balls_per_game: 1
```



```
machine:
  min_balls: 3

coils:
  eject_coil1:
    number:
  eject_coil2:
    number:
  eject_coil3:
    number:

switches:
  s_start:
    number:
    tags: start
  s_ball_switch1:
    number:
  s_ball_switch2:
    number:
  s_ball_switch3:
    number:
  s_ball_switch4:
    number:
  s_ball_switch_launcher:
    number:
  s_vuk:
    number:
  s_playfield:
    number:
    tags: playfield_active

ball_devices:
  test_trough:
    eject_coil: eject_coil1
    ball_switches: s_ball_switch1, s_ball_switch2, s_ball_switch3, s_ball_switch4
    debug: true
    eject_targets: test_launcher
    tags: trough, drain, home
  test_launcher:
    eject_coil: eject_coil2
    ball_switches: s_ball_switch_launcher
    tags: ball_add_live
    debug: true
  test_vuk:
    eject_coil: eject_coil3
    ball_switches: s_vuk
    debug: true
```


ball_device (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Note that there are multiple machine config examples here. They're just included to show different options. You wouldn't actually use more than one.

Listing 22.35: `your_machine_folder/config/test_ball_device.yaml`

```
#config_version=4

game:
  balls_per_game: 1

coils:
  eject_coil1:
    number:
  eject_coil2:
    number:
  eject_coil3:
    number:
  eject_coil4:
    number:
  eject_coil5:
    number:

switches:
  s_start:
    number:
    tags: start
  s_ball_switch1:
    number:
  s_ball_switch2:
    number:
  s_ball_switch_launcher:
    number:
  s_ball_switch_target1:
    number:
  s_ball_switch_target2_1:
    number:
  s_ball_switch_target2_2:
    number:
  s_ball_switch_target3:
    number:
  s_ball_switch_target3_2:
    number:
  s_playfield:
    number:
    tags: playfield_active
```



```

ball_devices:
  test_trough:
    eject_coil: eject_coil1
    ball_switches: s_ball_switch1, s_ball_switch2
    debug: true
    confirm_eject_type: target
    max_eject_attempts: 3
    eject_targets: test_launcher
    tags: trough, drain, home
  test_launcher:
    eject_coil: eject_coil2
    ball_switches: s_ball_switch_launcher
    debug: true
    confirm_eject_type: target
    eject_targets: test_target1, test_target2
    eject_timeouts: 6s, 10s
  test_target1:
    eject_coil: eject_coil3
    ball_switches: s_ball_switch_target1
    debug: true
    tags: ball_add_live
    confirm_eject_type: target
  test_target2:
    eject_coil: eject_coil4
    ball_switches: s_ball_switch_target2_1, s_ball_switch_target2_2
    debug: true
    tags: trough, drain, home
    confirm_eject_type: target
    eject_targets: test_target3
  test_target3:
    eject_coil: eject_coil5
    ball_switches: s_ball_switch_target3, s_ball_switch_target3_2
    eject_targets: playfield, test_trough
    confirm_eject_type: target
    debug: true

```

Listing 22.36: `your_machine_folder/config/test_ball_device_auto_manual_plunger.yaml`

```

#config_version=4

coils:
  trough_eject:
    number:
  plunger_eject:
    number:

switches:
  s_trough_1:
    number:
  s_trough_2:
    number:
  s_plunger:
    number:
  s_playfield:
    number:

```



```
    tags: playfield_active
  s_launch:
    number:
    tags: launch

ball_devices:
  trough:
    eject_coil: trough_eject
    ball_switches: s_trough_1, s_trough_2
    debug: true
    tags: trough, drain, home
    eject_targets: plunger
    confirm_eject_type: target
  plunger:
    eject_coil: plunger_eject
    ball_switches: s_plunger
    debug: true
    mechanical_eject: true
    tags: ball_add_live
    player_controlled_eject_event: sw_launch
```

Listing 22.37: `your_machine_folder/config/test_ball_device_event_confirmation.yaml`

```
#config_version=4

game:
  balls_per_game: 1

coils:
  eject_coil1:
    number:
  eject_coil2:
    number:
  eject_coil3:
    number:
  eject_coil4:
    number:
  eject_coil5:
    number:

switches:
  s_start:
    number:
    tags: start
  s_ball_switch1:
    number:
  s_ball_switch2:
    number:
  s_ball_switch_launcher:
    number:
  s_ball_switch_target1:
    number:
  s_ball_switch_target2_1:
    number:
  s_ball_switch_target2_2:
```



```

    number:
  s_ball_switch_target3:
    number:
  s_playfield:
    number:
    tags: playfield_active

ball_devices:
  test_trough:
    eject_coil: eject_coil1
    ball_switches: s_ball_switch1, s_ball_switch2
    debug: true
    confirm_eject_type: target
    eject_targets: test_launcher
    tags: trough, drain, home
  test_launcher:
    eject_coil: eject_coil2
    ball_switches: s_ball_switch_launcher
    debug: true
    confirm_eject_type: event
    confirm_eject_event: launcher_confirm
    eject_targets: test_target1, test_target2
    eject_timeouts: 6s, 10s
  test_target1:
    eject_coil: eject_coil3
    ball_switches: s_ball_switch_target1
    debug: true
    tags: ball_add_live
    confirm_eject_type: target
  test_target2:
    eject_coil: eject_coil4
    ball_switches: s_ball_switch_target2_1, s_ball_switch_target2_2
    debug: true
    tags: trough, drain, home
    confirm_eject_type: target
    eject_targets: test_target3
  test_target3:
    eject_coil: eject_coil5
    ball_switches: s_ball_switch_target3
    debug: true

```

Listing 22.38: `your_machine_folder/config/test_ball_device_jam_switch.yaml`

```
#config_version=4
```

```

coils:
  trough_eject:
    number:
  plunger_eject:
    number:

switches:
  s_trough_1:
    number:
  s_trough_2:

```



```

    number:
  s_trough_3:
    number:
  s_trough_4:
    number:
  s_trough_jam:
    number:
  s_plunger:
    number:
  s_playfield:
    number:
    tags: playfield_active
  s_launch:
    number:
    tags: launch

ball_devices:
  trough:
    eject_coil: trough_eject
    ball_switches: s_trough_1, s_trough_2, s_trough_3, s_trough_4, s_trough_jam
    jam_switch: s_trough_jam
    debug: true
    tags: trough, drain, home
    eject_targets: plunger
    confirm_eject_type: target
    eject_coil_jam_pulse: 5
    eject_coil_retry_pulse: 15
  plunger:
    eject_coil: plunger_eject
    ball_switches: s_plunger
    debug: true
    mechanical_eject: true
    tags: ball_add_live
    player_controlled_eject_event: sw_launch

```

Listing 22.39: `your_machine_folder/config/test_ball_device_manual_with_target.yaml`

```
#config_version=4
```

```

coils:
  eject_coil1:
    number:
  eject_coil2:
    number:
  eject_coil3:
    number:
  eject_coil4:
    number:
  eject_coil5:
    number:
  eject_coil6:
    number:

```

```
switches:
```



```
s_ball_switch1:
  number:
s_ball_switch2:
  number:
s_ball_switch_launcher:
  number:
s_ball_switch_launcher2:
  number:
s_ball_switch_target:
  number:
s_playfield:
  number:
  tags: playfield_active
s_launch:
  number:
  tags: launch
s_vuk:
  number:

ball_devices:
  test_trough:
    eject_coil: eject_coil1
    ball_switches: s_ball_switch1, s_ball_switch2
    debug: true
    confirm_eject_type: target
    eject_targets: test_launcher
    eject_timeouts: 3s
    tags: trough, drain, home
  test_launcher:
    eject_coil: eject_coil2
    ball_switches: s_ball_switch_launcher
    debug: true
    eject_timeouts: 6s, 10s
    eject_targets: playfield, test_target
    mechanical_eject: true
    confirm_eject_type: target
    tags: ball_add_live
  test_target:
    eject_coil: eject_coil3
    ball_switches: s_ball_switch_target
    debug: true
    eject_timeouts: 6s
    confirm_eject_type: target
  test_launcher_manual_on_unexpected:
    eject_coil: eject_coil4
    ball_switches: s_ball_switch_launcher2
    debug: true
    eject_timeouts: 6s
    eject_targets: playfield
    mechanical_eject: true
    auto_fire_on_unexpected_ball: false
    confirm_eject_type: target
  test_vuk:
```



```
eject_coil: eject_coil5
ball_switches: s_vuk
debug: true
eject_timeouts: 3s
eject_targets: test_launcher
auto_fire_on_unexpected_ball: false
confirm_eject_type: target
```

Listing 22.40: `your_machine_folder/config/test_ball_device_no_plunger_switch.yaml`

```
#config_version=4

coils:
  trough_eject:
    number:

switches:
  s_trough_1:
    number:
  s_trough_2:
    number:
  s_trough_3:
    number:
  s_trough_4:
    number:
  s_trough_jam:
    number:
  s_playfield:
    number:
    tags: playfield_active

ball_devices:
  trough:
    eject_coil: trough_eject
    ball_switches: s_trough_1, s_trough_2, s_trough_3, s_trough_4
    debug: true
    tags: trough, drain, home, ball_add_live
```

Listing 22.41: `your_machine_folder/config/test_ball_device_routing.yaml`

```
#config_version=4

game:
  balls_per_game: 1

coils:
  c_trough1:
    number:
  c_trough2:
    number:
  c_launcher:
    number:
  c_target1:
    number:
  c_drain1:
```



```

    number:

switches:
  s_trough1_1:
    number:
  s_trough1_2:
    number:
  s_trough2_1:
    number:
  s_trough2_2:
    number:
  s_launcher:
    number:
  s_target1:
    number:
  s_drain1:
    number:
  s_playfield:
    number:
    tags: playfield_active

ball_devices:
  test_trough1:
    eject_coil: c_trough1
    ball_switches: s_trough1_1, s_trough1_2
    eject_targets: test_launcher
    tags: trough, drain, home
  test_launcher:
    eject_coil: c_launcher
    ball_switches: s_launcher
    eject_targets: test_trough2, test_target1
  test_target1:
    eject_coil: c_target1
    ball_switches: s_target1
    tags: ball_add_live
  test_trough2:
    eject_coil: c_trough2
    ball_switches: s_trough2_1, s_trough2_2
    tags: trough, drain, home
    confirm_eject_type: target
  test_drain:
    eject_coil: c_drain1
    ball_switches: s_drain1
    tags: drain
    eject_targets: playfield, test_target1, test_trough2

```

Listing 22.42: `your_machine_folder/config/test_ball_device_switch_confirmation.yaml`

```

#config_version=4

game:
  balls_per_game: 1

coils:
  eject_coil1:

```



```
    number:
  eject_coil2:
    number:
  eject_coil3:
    number:
  eject_coil4:
    number:
  eject_coil5:
    number:

switches:
  s_start:
    number:
    tags: start
  s_ball_switch1:
    number:
  s_ball_switch2:
    number:
  s_ball_switch_launcher:
    number:
  s_launcher_confirm:
    number:
  s_ball_switch_target1:
    number:
  s_ball_switch_target2_1:
    number:
  s_ball_switch_target2_2:
    number:
  s_ball_switch_target3:
    number:
  s_playfield:
    number:
    tags: playfield_active

ball_devices:
  test_trough:
    eject_coil: eject_coil1
    ball_switches: s_ball_switch1, s_ball_switch2
    debug: true
    confirm_eject_type: target
    eject_targets: test_launcher
    tags: trough, drain, home
  test_launcher:
    eject_coil: eject_coil2
    ball_switches: s_ball_switch_launcher
    confirm_eject_switch: s_launcher_confirm
    debug: true
    confirm_eject_type: switch
    eject_targets: test_target1, test_target2
    eject_timeouts: 6s, 10s
  test_target1:
    eject_coil: eject_coil3
    ball_switches: s_ball_switch_target1
    debug: true
    tags: ball_add_live
```



```
    confirm_eject_type: target
test_target2:
  eject_coil: eject_coil4
  ball_switches: s_ball_switch_target2_1, s_ball_switch_target2_2
  debug: true
  tags: trough, drain, home
  confirm_eject_type: target
  eject_targets: test_target3
test_target3:
  eject_coil: eject_coil5
  ball_switches: s_ball_switch_target3
  debug: true
```

Listing 22.43: `your_machine_folder/config/test_ball_device_trigger_events.yaml`

```
#config_version=4

coils:
  eject_coil1:
    number:
  eject_coil2:
    number:
  eject_coil3:
    number:
  eject_coil4:
    number:
  eject_coil5:
    number:
  c_diverter:
    number:

switches:
  s_ball_switch1:
    number:
  s_ball_switch2:
    number:
  s_ball_switch_launcher:
    number:
  s_ball_switch_target:
    number:
  s_playfield:
    number:
    tags: playfield_active
  s_launch:
    number:
    tags: launch

ball_devices:
  test_trough:
    eject_coil: eject_coil1
    ball_switches: s_ball_switch1, s_ball_switch2
    debug: true
```



```
    confirm_eject_type: target
    eject_targets: test_launcher
    eject_timeouts: 3s
    tags: trough, drain, home
test_launcher:
    eject_coil: eject_coil2
    ball_switches: s_ball_switch_launcher
    debug: true
    eject_timeouts: 6s, 10s
    eject_targets: playfield, test_target
    confirm_eject_type: target
    tags: ball_add_live
    player_controlled_eject_event: sw_launch
test_target:
    eject_coil: eject_coil3
    ball_switches: s_ball_switch_target
    debug: true
    eject_timeouts: 6s
    confirm_eject_type: target
```

Listing 22.44: `your_machine_folder/config/test_gottlieb_trough.yaml`

```
#config_version=4

game:
    balls_per_game: 3
    allow_start_with_ball_in_drain: True
machine:
    min_balls: 3

coils:
    outhole:
        number: 1
    trough:
        number: 2

switches:
    start:
        number: 1
        tags: start
    outhole:
        number: 2
    trough_entry:
        number: 3
    plunger:
        number: 4
    playfield:
        number: 5
        tags: playfield_active

ball_devices:
    outhole:
        tags: drain
        ball_switches: outhole
        eject_timeouts: 2s
```



```
eject_coil: outhole
eject_targets: trough
confirm_eject_type: target
debug: true
trough:
  tags: trough, home
  entrance_switch: trough_entry
  entrance_switch_full_timeout: 3s
  eject_coil: trough
  eject_targets: plunger
  confirm_eject_type: target
  ball_capacity: 3
  debug: true
plunger:
  tags: ball_add_live
  ball_switches: plunger
  mechanical_eject: true
  eject_timeouts: 4s
  debug: true
```

Listing 22.45: `your_machine_folder/config/test_gottlieb_trough_with_initial_balls.yaml`

```
#config_version=4

config: test_gottlieb_trough.yaml

virtual_platform_start_active_switches:
  trough_entry
```

Listing 22.46: `your_machine_folder/config/test_hold_coil.yaml`

```
#config_version=4

coils:
  hold_coil:
    number:
  hold_coil2:
    number:
  hold_coil3:
    number:
  hold_coil4:
    number:

switches:
  s_entrance:
    number:
  s_entrance2:
    number:
  s_entrance_and_hold3:
    number:
  s_ball4_1:
    number:
  s_ball4_2:
    number:
```



```
ball_devices:
  test:
    hold_coil: hold_coil
    entrance_switch: s_entrance
    hold_events: test_hold_event
    ball_capacity: 3
    debug: true
    confirm_eject_type: fake
  test2:
    hold_coil: hold_coil2
    entrance_switch: s_entrance2
    hold_events: test_hold_event2
    ball_capacity: 3
    tags: trough, home
    debug: true
    confirm_eject_type: fake
  test3:
    hold_coil: hold_coil3
    entrance_switch: s_entrance_and_hold3
    hold_switches: s_entrance_and_hold3
    tags: trough, home
    debug: true
    eject_timeouts: 2s
    ball_capacity: 2
  test4:
    hold_coil: hold_coil4
    hold_switches: s_ball4_1, s_ball4_2
    ball_switches: s_ball4_1, s_ball4_2
    tags: trough, home
    debug: true
```

Listing 22.47: your_machine_folder/config/test_single_device.yaml

```
#config_version=4

coils:
  c_eject:
    number:

switches:
  s_trough:
    number:

virtual_platform_start_active_switches:
  s_trough

ball_devices:
  trough:
    eject_coil: c_eject
    ball_switches: s_trough
    tags: home, trough, drain, ball_add_live
    debug: True
```


Listing 22.48: your_machine_folder/config/test_system_11_trough.yaml

```
#config_version=4

game:
  balls_per_game: 3
  allow_start_with_ball_in_drain: True

coils:
  outhole:
    number: C09
    pulse_ms: 20
  trough:
    number: C10
    pulse_ms: 20

switches:
  start:
    number: S13
    tags: start
  outhole:
    number: S15
  trough1:
    number: S16
  trough2:
    number: S17
  trough3:
    number: S18
  plunger:
    number: S28
  playfield:
    number:
    tags: playfield_active

ball_devices:
  outhole:
    tags: drain
    ball_switches: outhole
    eject_coil: outhole
    eject_targets: trough
    confirm_eject_type: target
    debug: true
  trough:
    tags: trough, home
    ball_switches: trough1, trough2, trough3
    eject_coil: trough
    eject_targets: plunger
    confirm_eject_type: target
    debug: true
  plunger:
    tags: ball_add_live
    ball_switches: plunger
    mechanical_eject: true
    eject_timeouts: 4s
#    ball_missing_timeouts: 1s
```



```
debug: true
```

Listing 22.49: `your_machine_folder/config/test_system_11_trough_startup.yaml`

```
#config_version=4

config: test_system_11_trough.yaml

virtual_platform_start_active_switches:
  - trough1
  - trough2
  - trough3
  - outhole
```

Listing 22.50: `your_machine_folder/config/test_too_long_exit_count_delay.yaml`

```
#config_version=4

coils:
  trough_eject:
    number:
  plunger_eject:
    number:

switches:
  s_trough_1:
    number:
  s_trough_2:
    number:
  s_trough_3:
    number:
  s_trough_4:
    number:
  s_trough_jam:
    number:
  s_plunger:
    number:
  s_playfield:
    number:
    tags: playfield_active
  s_launch:
    number:
    tags: launch

ball_devices:
  trough:
    eject_coil: trough_eject
    ball_switches: s_trough_1, s_trough_2, s_trough_3, s_trough_4, s_trough_jam
    jam_switch: s_trough_jam
    debug: true
    tags: trough, drain, home
    eject_targets: plunger
    confirm_eject_type: target
    exit_count_delay: 3s
  plunger:
```



```
eject_coil: plunger_eject
ball_switches: s_plunger
debug: true
#   mechanical_eject: true
tags: ball_add_live
player_controlled_eject_event: sw_launch
exit_count_delay: 300ms
```

ball_holds (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.51: `your_machine_folder/config/test_ball_holds.yaml`

```
#config_version=4

game:
  balls_per_game: 1

modes:
  - model

coils:
  eject_coil1:
    number:
  eject_coil2:
    number:
  eject_coil3:
    number:
  eject_coil4:
    number:

switches:
  s_start:
    number:
    tags: start
  s_ball_switch1:
    number:
  s_ball_switch2:
    number:
  s_ball_switch_launcher:
    number:
  s_ball_switch_hold1:
    number:
  s_ball_switch_hold2:
    number:
  s_ball_switch_hold3:
    number:
  s_ball_switch_hold4:
    number:
```



```

s_ball_switch_hold5:
  number:
s_playfield_active:
  tags: playfield_active
  number:

ball_devices:
  test_trough:
    eject_coil: eject_coil1
    ball_switches: s_ball_switch1, s_ball_switch2
    debug: true
    confirm_eject_type: target
    eject_targets: test_launcher
    tags: trough, drain, home
  test_launcher:
    eject_coil: eject_coil2
    ball_switches: s_ball_switch_launcher
    debug: true
    confirm_eject_type: target
    eject_timeouts: 6s, 10s
    tags: ball_add_live
  test_hold:
    eject_coil: eject_coil3
    ball_switches: s_ball_switch_hold1, s_ball_switch_hold2, s_ball_switch_hold3
    confirm_eject_type: target
    debug: true
  test_hold2:
    eject_coil: eject_coil4
    ball_switches: s_ball_switch_hold4, s_ball_switch_hold5
    confirm_eject_type: target
    debug: true

ball_holds:
  hold_test:
    hold_devices: test_hold
    balls_to_hold: 2
    release_one_events: release_test
  hold_test3:
    hold_devices: test_hold2

event_player:
  test_conditional_event{device.ball_holds.hold_test["balls_held"] > 0}:
    - "yes"
  test_conditional_event{device.ball_holds.hold_test["balls_held"] == 0}:
    - "no"

```

Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Listing 22.52: `your_machine_folder/modes/mode1/config/mode1.yaml`

```
#config_version=4
mode:
  start_events: start_mode1
  stop_events: stop_mode1
  game_mode: False

ball_holds:
  hold_test2:
    hold_devices: test_hold
    balls_to_hold: 2
    release_one_events: release_test
    tags:
    label:
```

ball_lock (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.53: `your_machine_folder/config/test_ball_lock.yaml`

```
#config_version=4

game:
  balls_per_game: 1

modes:
  - mode1

coils:
  eject_coil1:
    number:
  eject_coil2:
    number:
  eject_coil3:
    number:

switches:
  s_start:
    number:
    tags: start
  s_ball_switch1:
    number:
  s_ball_switch2:
    number:
  s_ball_switch_launcher:
    number:
  s_ball_switch_lock1:
    number:
```



```

s_ball_switch_lock2:
  number:
s_ball_switch_lock3:
  number:
s_playfield_active:
  tags: playfield_active
  number:

ball_devices:
  test_trough:
    eject_coil: eject_coil1
    ball_switches: s_ball_switch1, s_ball_switch2
    debug: true
    confirm_eject_type: target
    eject_targets: test_launcher
    tags: trough, drain, home
  test_launcher:
    eject_coil: eject_coil2
    ball_switches: s_ball_switch_launcher
    debug: true
    confirm_eject_type: target
    eject_timeouts: 6s, 10s
    tags: ball_add_live
  test_lock:
    eject_coil: eject_coil3
    ball_switches: s_ball_switch_lock1, s_ball_switch_lock2, s_ball_switch_lock3
    confirm_eject_type: target
    debug: true

ball_locks:
  lock_test:
    lock_devices: test_lock
    balls_to_lock: 2
    release_one_events: release_test

```

Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Listing 22.54: `your_machine_folder/modes/mode1/config/mode1.yaml`

```

#config_version=4
mode:
  start_events: start_mode1
  stop_events: stop_mode1
  game_mode: False

ball_locks:
  lock_test2:
    lock_devices: test_lock
    balls_to_lock: 2
    release_one_events: release_test
    tags:
    label:

```


ball_save (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.55: `your_machine_folder/config/config.yaml`

```
#config_version=4

game:
  balls_per_game: 1

modes:
  - model

coils:
  eject_coil1:
    number:
  eject_coil2:
    number:

switches:
  s_start:
    number:
    tags: start
  s_ball_switch1:
    number:
  s_ball_switch2:
    number:
  s_ball_switch_launcher:
    number:
  s_left_outlane:
    number:

ball_devices:
  bd_trough:
    eject_coil: eject_coil1
    ball_switches: s_ball_switch1, s_ball_switch2
    debug: true
    confirm_eject_type: target
    eject_targets: bd_launcher
    tags: trough, drain, home
  bd_launcher:
    eject_coil: eject_coil2
    ball_switches: s_ball_switch_launcher
    debug: true
    confirm_eject_type: target
    eject_timeouts: 2s
    tags: ball_add_live

ball_saves:
  default:
    active_time: 10s
```



```
hurry_up_time: 2s
grace_period: 2s
enable_events: enable1
timer_start_events: balldevice_bd_launcher_ball_eject_success
early_ball_save_events: s_left_outlane_active
auto_launch: yes
balls_to_save: 1
debug: yes
unlimited:
  active_time: 30s
  hurry_up_time: 2s
  grace_period: 2s
  enable_events: enable2
  early_ball_save_events: s_left_outlane_active
  auto_launch: yes
  balls_to_save: -1
  debug: yes
only_last:
  enable_events: enable3
  only_last_ball: True
  debug: yes
eject_delay:
  enable_events: enable4
  eject_delay: 1s
  debug: yes
unlimited_delay:
  enable_events: enable5
  delayed_eject_events: eject5
```

Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Listing 22.56: `your_machine_folder/modes/mode1/config/mode1.yaml`

```
#config_version=4
mode:
  start_events: start_mode1
  stop_events: stop_mode1
  game_mode: False

ball_saves:
  mode_ball_save:
    active_time: 10s
    hurry_up_time: 2s
    grace_period: 2s
    timer_start_events: balldevice_bd_launcher_ball_eject_success
    auto_launch: yes
    balls_to_save: 1
    debug: yes
```

ball_search (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Note that there are multiple machine config examples here. They're just included to show different options. You wouldn't actually use more than one.

Listing 22.57: `your_machine_folder/config/config.yaml`

```
#config_version=4

game:
  balls_per_game: 1

machine:
  min_balls: 1

coils:
  eject_coil1:
    number:
  eject_coil2:
    number:
  eject_coil3:
    number:
  hold_coil:
    number:
  drop_target_reset1:
    number:
  drop_target_reset2:
    number:
  drop_target_knockdown2:
    number:
```



```
drop_target_reset3:
  number:
drop_target_reset4:
  number:
drop_target_knockdown4:
  number:
flipper_coil:
  number:
diverter_coil:
  number:
autofire_coil:
  number:

playfields:
  playfield:
    enable_ball_search: True
    ball_search_timeout: 20s
    ball_search_wait_after_iteration: 10s
    ball_search_interval: 250ms

servos:
  serv01:
    number:
    reset_events:

switches:
  s_start:
    number:
    tags: start
  s_ball_switch1:
    number:
  s_ball_switch2:
    number:
  s_ball_switch3:
    number:
  s_ball_switch4:
    number:
  s_ball_switch_launcher:
    number:
  s_vuk:
    number:
  s_lock:
    number:
  s_playfield:
    number:
    tags: playfield_active
  s_drop_target1:
    number:
  s_drop_target2:
    number:
  s_drop_target3:
    number:
  s_drop_target4:
    number:
  s_autofire:
```



```
    number:
s_flipper:
    number:

drop_targets:
  target1:
    reset_coil: drop_target_reset1
    switch: s_drop_target1
    ball_search_order: 10
  target2:
    reset_coil: drop_target_reset2
    knockdown_coil: drop_target_knockdown2
    switch: s_drop_target2
    ball_search_order: 11
  target3:
    reset_coil: drop_target_reset3
    switch: s_drop_target3
    ball_search_order: 12
  target4:
    reset_coil: drop_target_reset4
    knockdown_coil: drop_target_knockdown4
    switch: s_drop_target4
    ball_search_order: 13

ball_devices:
  test_trough:
    eject_coil: eject_coil1
    ball_switches: s_ball_switch1, s_ball_switch2, s_ball_switch3, s_ball_switch4
    debug: true
    eject_targets: test_launcher
    tags: trough, drain, home
    ball_search_order: 1
  test_launcher:
    eject_coil: eject_coil2
    ball_switches: s_ball_switch_launcher
    tags: ball_add_live
    eject_timeouts: 5s
    eject_coil_jam_pulse: 5ms
    debug: true
    ball_search_order: 2
  test_vuk:
    eject_coil: eject_coil3
    ball_switches: s_vuk
    eject_timeouts: 2s
    debug: true
    ball_search_order: 3
  test_lock:
    hold_coil: hold_coil
    ball_switches: s_lock
    eject_timeouts: 2s
    debug: true
    ball_search_order: 4

diverters:
  diverter1:
```



```

    activation_coil: diverter_coil
    ball_search_order: 14

flippers:
  flipper1:
    main_coil: flipper_coil
    activation_switch: s_flipper
    ball_search_order: 15
    include_in_ball_search: True

autofire_coils:
  autofire1:
    coil: autofire_coil
    switch: s_autofire
    ball_search_order: 16

```

Listing 22.58: `your_machine_folder/config/missing_initial.yaml`

```

#config_version=4

machine:
  balls_installed: 3

config:
  - config.yaml

virtual_platform_start_active_switches:
  - s_ball_switch1

```

bcp (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Note that there are multiple machine config examples here. They're just included to show different options. You wouldn't actually use more than one.

Listing 22.59: `your_machine_folder/config/config.yaml`

```

#config_version=4

modes:
  - mode1
  - Mode2

switches:
  s_test:
    number:
  s_test2:
    number:
  s_start:

```



```
    number:
    tags: start
  s_ball_switch1:
    number:
  s_ball_switch2:
    number:
  s_ball_switch_launcher:
    number:

game:
  balls_per_game: 3

coils:
  eject_coil1:
    number:
  eject_coil2:
    number:

ball_devices:
  bd_trough:
    eject_coil: eject_coil1
    ball_switches: s_ball_switch1, s_ball_switch2
    debug: true
    confirm_eject_type: target
    eject_targets: bd_launcher
    tags: trough, drain, home
  bd_launcher:
    eject_coil: eject_coil2
    ball_switches: s_ball_switch_launcher
    debug: true
    confirm_eject_type: target
    eject_timeouts: 2s
    tags: ball_add_live
```

Listing 22.60: `your_machine_folder/config/test_bcp_processor.yaml`

```
#config_version=4
```

Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Note that there are multiple mode config examples here. You might not necessarily use more than one in your machine.

Listing 22.61: `your_machine_folder/modes/mode1/mode1.yaml`

```
#config_version=4

mode:
  start_events: start_mode1
  stop_events: stop_mode1
  game_mode: False
```


Listing 22.62: `your_machine_folder/modes/mode2/mode2.yaml`

```
#config_version=4

mode:
  start_events: start_mode2
  stop_events: stop_mode2
  game_mode: False
```

bonus (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.63: `your_machine_folder/config/config.yaml`

```
#config_version=4

modes:
  - bonus
  - mode1

machine:
  min_balls: 0

game:
  balls_per_game: 10 # we have a lot of bonus tests to run :)

switches:
  s_start:
    number:
    tags: start

player_vars:
  bonus_multiplier:
    initial_value: 1
```

Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Note that there are multiple mode config examples here. You might not necessarily use more than one in your machine.

Listing 22.64: `your_machine_folder/modes/bonus/config/bonus.yaml`

```
#config_version=4

mode_settings:
  keep_multiplier: True
```



```
bonus_entries:
  - event: bonus_ramps
    score: 1000
    player_score_entry: ramps
    reset_player_score_entry: True
    skip_if_zero: false
  - event: bonus_modes
    score: 5000
    player_score_entry: modes
    reset_player_score_entry: False
```

Listing 22.65: `your_machine_folder/modes/mode1/config/mode1.yaml`

```
#config_version=4
mode:
  start_events: start_mode1
  stop_events: stop_mode1
  priority: 200

scoring:
  hit_target:
    score: 1337
  score_ramps:
    ramps: 1
  score_modes:
    modes: 1
  add_multiplier:
    bonus_multiplier: 1
```

carousel (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.66: `your_machine_folder/config/config.yaml`

```
#config_version=4

modes:
  - carousel
  - second_carousel

machine:
  min_balls: 0

switches:
  s_start:
    number:
    tags: start
```


Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Note that there are multiple mode config examples here. You might not necessarily use more than one in your machine.

Listing 22.67: `your_machine_folder/modes/carousel/config/carousel.yaml`

```
#config_version=4
mode:
  start_events: start_model
  stop_events: stop_model, carousel_item_selected
  code: mpf.modes.carousel.code.carousel.Carousel

mode_settings:
  selectable_items: item1, item2, item3
  select_item_events: select, select_additional
  next_item_events: next, next2
  previous_item_events: previous, previous2
```

Listing 22.68: `your_machine_folder/modes/second_carousel/config/second_carousel.yaml`

```
#config_version=4
mode:
  start_events: start_model
  stop_events: stop_model, carousel_item_selected
  code: mpf.modes.carousel.code.carousel.Carousel

mode_settings:
  selectable_items: item1, item2, item3
  select_item_events: select, select_additional
  next_item_events: next, next2
  previous_item_events: previous, previous2
```

coil_player (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.69: `your_machine_folder/config/coil_player.yaml`

```
#config_version=4

coils:
  coil_1:
    number:
    allow_enable: true
  coil_2:
    number:
  coil_3:
```



```
    number:
      allow_enable: true

coil_player:
  event1: coil_1
  event2:
    coil_1:
      action: pulse
    coil_2:
      action: pulse
  event3:
    coil_1:
      action: pulse
      ms: 49
  event4:
    coil_1:
      action: enable
  event5:
    coil_1:
      action: disable
  event6: coil_2
  event7:
    coil_3: enable
  event8:
    coil_3: disable
  event9:
    coil_3: 30
```

color (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.70: [your_machine_folder/config/test_color.yaml](#)

```
#config_version=4

displays:
  default:
    width: 400
    height: 300

slides:
  slide1:
    - type: text
      text: RED
      color: red
      y: 75
    - type: text
      text: 0000FF80
      color: 0000ff80
```



```
- type: text
  text: 00FF00
  color: 00ff00

slide_player:
  slide1: slide1
```

combo_switches (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.71: `your_machine_folder/config/combo_switches.yaml`

```
#config_version=4

modes:
  - mode1

switches:
  switch1:
    number:
  switch2:
    number:
  switch3:
    number:
  switch4:
    number:
  switch5:
    number:
    tags: tag1
  switch6:
    number:
    tags: tag1
  switch7:
    number:
    tags: tag2
  switch8:
    number:
    tags: tag2
  switch9:
    number:
    tags: left_flipper
  switch10:
    number:
    tags: right_flipper

combo_switches:
  tag_combo:
    tag_1: tag1
```



```
    tag_2: tag2
switch_combo:
    switches_1: switch1
    switches_2: switch2
multiple_switch_combo:
    switches_1: switch1, switch2
    switches_2: switch3, switch4
custom_offset:
    switches_1: switch1
    switches_2: switch2
    max_offset_time: 1s
custom_hold:
    switches_1: switch1
    switches_2: switch2
    hold_time: 1s
custom_release:
    switches_1: switch1
    switches_2: switch2
    release_time: 1s
custom_times_multiple_switches:
    tag_1: tag1
    tag_2: tag2
    max_offset_time: 1s
    hold_time: 1s
    release_time: 1s
    debug: true
custom_events:
    switches_1: switch1
    switches_2: switch2
    events_when_both: active_event, active_event2
    events_when_inactive: inactive_event
    events_when_one: one_event
```

Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Listing 22.72: `your_machine_folder/modes/mode1/config/mode1.yaml`

```
#config_version=4

mode:
  priority: 100
  game_mode: no

combo_switches:
  mode1_combo:
    switches_1: switch1
    switches_2: switch2
```

config_interface (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Note that there are multiple machine config examples here. They're just included to show different options. You wouldn't actually use more than one.

Listing 22.73: `your_machine_folder/config/test_config_interface.yaml`

```
#config_version=4

game:
  balls_per_game: 1

test_section:
  true_key1: true
  true_key2: True
  true_key3: yes
  true_key4: Yes
  false_key1: false
  false_key2: False
  false_key3: no
  false_key4: No
  on_string: on
  off_string: off
  int_6400: 6400
  str_001: 001
  int_100: 100
  int_6: 6
  int_7: 07
  str_00ff00: 00ff00
  str_003200: 003200
  str_plus5: +5
  str_plus0point5: +0.5
  case_sensitive_1: test
  Case_sensitive_2: test
  case_sensitive_3: Test
```



```
Test_section_1:
  test: test
```

Listing 22.74: `your_machine_folder/config/test_config_interface_missing_version.yaml`

```
game:
  balls_per_game: 1
```

Listing 22.75: `your_machine_folder/config/test_config_interface_old_version.yaml`

```
#config_version=2

game:
  balls_per_game: 1
```

config_players (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.76: `your_machine_folder/config/test_config_players.yaml`

```
#config_version=4
modes:
  - mode1
  - mode2

banana_player:
  event1: express
  event2:
    some: key
  event3:
    this_banana:
      some: key
    that_banana:
      some: key

show_player:
  event4: show1
```

Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Note that there are multiple mode config examples here. You might not necessarily use more than one in your machine.

Listing 22.77: `your_machine_folder/modes/mode1/config/mode1.yaml`

```
#config_version=4

mode:
  priority: 100
  game_mode: False

banana_player:
  event5: express

show_player:
  event6: mode1_show
```

Listing 22.78: `your_machine_folder/modes/mode1/shows/mode1_show.yaml`

```
#show_version=4

- time: 0
  bananas:
    banana2: express
- time: 2
```

Listing 22.79: `your_machine_folder/modes/mode2/config/mode2.yaml`

```
#config_version=4

mode:
  priority: 200
  game_mode: False

banana_player:
```

Show file examples

Here are some example show files that go along with the above config(s).

Listing 22.80: `your_machine_folder/shows/show1.yaml`

```
#show_version=4

- time: 0
  bananas:
    banana1: express
- time: 2
```

credits (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Note that there are multiple machine config examples here. They're just included to show different options. You wouldn't actually use more than one.

Listing 22.81: [your_machine_folder/config/config.yaml](#)

```
#config_version=4

modes:
  - credits

machine:
  min_balls: 0

switches:
  s_left_coin:
    number:
  s_center_coin:
    number:
  s_right_coin:
    number:
  s_esc:
    number:
  s_start:
    number:
    tags: start

coils:
  c_eject:
    number:

credits:
  max_credits: 12
  free_play: no
  service_credits_switch: s_esc
  switches:
    - switch: s_left_coin
      type: money
      value: .25
    - switch: s_center_coin
      type: money
      value: .25
    - switch: s_right_coin
      type: money
      value: 1
  pricing_tiers:
    - price: .50
      credits: 1
    - price: 2
      credits: 5
  fractional_credit_expiration_time: 15m
  credit_expiration_time: 2h
  persist_credits_while_off_time: 1h
  free_play_string: FREE PLAY
  credits_string: CREDITS
```


Listing 22.82: `your_machine_folder/config/config_freeplay.yaml`

```
#config_version=4

modes:
  - credits

machine:
  min_balls: 0

switches:
  s_left_coin:
    number:
  s_center_coin:
    number:
  s_right_coin:
    number:
  s_esc:
    number:
  s_start:
    number:
    tags: start

coils:
  c_eject:
    number:

credits:
  max_credits: 12
  free_play: yes
  service_credits_switch: s_esc
  switches:
    - switch: s_left_coin
      type: money
      value: .25
    - switch: s_center_coin
      type: money
      value: .25
    - switch: s_right_coin
      type: money
      value: 1
  pricing_tiers:
    - price: .50
      credits: 1
    - price: 2
      credits: 5
  fractional_credit_expiration_time: 15m
  credit_expiration_time: 2h
  persist_credits_while_off_time: 1h
  free_play_string: FREE PLAY
  credits_string: CREDITS
```


Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Listing 22.83: `your_machine_folder/modes/credits/config/config.yaml`

```
#config_version=4

mode:
  priority: 11000
  start_events: machine_reset_phase_3
  stop_on_ball_end: False
```

device (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Note that there are multiple machine config examples here. They're just included to show different options. You wouldn't actually use more than one.

Listing 22.84: `your_machine_folder/config/config.yaml`

```
#config_version=4

matrix_lights:
  light_01:
    number: 0
    label: Test 0
  light_02:
    number: 1
    label: Test 1

gis:
  gi_01:
    number: 1
  gi_02:
    number: 2

coils:
  coil_01:
    number: 1
    pulse_ms: 30
  coil_02:
    number: 2
    pulse_ms: 60
  coil_03:
    number: 3

flashers:
  flasher_01:
    number: 1
```



```
    label: Test flasher
    flash_ms: 40
  flasher_02:
    number: 2
    label: Test flasher 2
    flash_ms: 100
  flasher_03:
    number: 3
```

Listing 22.85: `your_machine_folder/config/config_dual_wound_coil.yaml`

```
#config_version=4

coils:
  c_hold:
    number:
    allow_enable: True
  c_power:
    number:
    pulse_ms: 20

switches:
  s_eos:
    number:

dual_wound_coils:
  c_test:
    hold_coil: c_hold
    main_coil: c_power
  c_test_eos:
    hold_coil: c_hold
    main_coil: c_power
    eos_switch: s_eos
```

device_collection (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.86: `your_machine_folder/config/test_device_collection.yaml`

```
#config_version=4

leds:
  led1:
    number: 1
    tags: tag1, tag2
  led2:
    number: 2
    tags: tag1
```



```
led3:
  number: 3
  tags: tag2
led4:
  number: 4
```

display (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Note that there are multiple machine config examples here. They're just included to show different options. You wouldn't actually use more than one.

Listing 22.87: `your_machine_folder/config/test_display_multiple.yaml`

```
#config_version=4
displays:
  window:
    width: 401
    height: 301
  display2:
    width: 402
    height: 302
    default: true
```

Listing 22.88: `your_machine_folder/config/test_display_none.yaml`

```
# config_version=4
```

Listing 22.89: `your_machine_folder/config/test_display_single.yaml`

```
#config_version=4
displays:
  window:
    width: 401
    height: 301
```

diverter (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Note that there are multiple machine config examples here. They're just included to show different options. You wouldn't actually use more than one.

Listing 22.90: `your_machine_folder/config/config.yaml`

```
#config_version=4

coils:
  eject_coil1:
    number: 1
  eject_coil2:
    number: 2
  c_diverter:
    number: 3
  c_diverter_disable:
    number: 4

switches:
  s_ball_switch1:
    number: 1
  s_ball_switch2:
    number: 2
  s_diverter:
    number: 3
  s_playfield:
    number: 4
    tags: playfield_active
  s_target:
    number: 5

ball_devices:
  test_trough:
    eject_coil: eject_coil1
    ball_switches: s_ball_switch1, s_ball_switch2
    confirm_eject_type: target
    eject_targets: test_target, playfield
    tags: trough, drain, home
  test_target:
    eject_coil: eject_coil2
    ball_switches: s_target
    confirm_eject_type: target
    eject_targets: playfield

virtual_platform_start_active_switches:
- s_ball_switch1
- s_ball_switch2
```

Listing 22.91: `your_machine_folder/config/test_activation_switch_and_eject_confirm_switch.yaml`

```
#config_version=4

config:
- config.yaml

diverters:
  d_test_hold_activation_time:
    activation_coil: c_diverter
    activation_switches: s_diverter
```



```

    type: hold
    feeder_devices: test_trough2
    targets_when_active: playfield
    targets_when_inactive: test_target
    activation_time: 4s
    debug: True

coils:
  eject_coil3:
    number: 10

switches:
  s_ball_switch3:
    number: 10
  s_ball_switch4:
    number: 11
  s_diverter:
    number: 12

ball_devices:
  test_trough2:
    eject_coil: eject_coil3
    ball_switches: s_ball_switch3, s_ball_switch4
    confirm_eject_type: switch
    confirm_eject_switch: s_diverter
    eject_targets: test_target, playfield
    tags: trough, drain, home

virtual_platform_start_active_switches:
  - s_ball_switch3
  - s_ball_switch4

```

Listing 22.92: `your_machine_folder/config/test_delayed_eject.yaml`

```

#config_version=4

config:
- config.yaml

diverters:
  d_test_delayed_eject:
    activation_coil: c_diverter
    type: hold
    feeder_devices: test_trough
    targets_when_active: playfield
    targets_when_inactive: test_target
    activation_time: 4s
    debug: True

```

Listing 22.93: `your_machine_folder/config/test_diverter_auto_disable.yaml`

```

#config_version=4

diverters:
  d_test:

```



```
    activation_coil: c_diverter
    type: hold
    debug: True
    activation_switches: s_activate
    disable_switches: s_disable

coils:
  c_diverter:
    number: 10

switches:
  s_activate:
    number: 1
  s_disable:
    number: 2
```

Listing 22.94: `your_machine_folder/config/test_diverter_dual_wound_coil.yaml`

```
#config_version=4

config:
- config.yaml

coils:
  c_hold:
    number: 5
  c_power:
    number: 6

dual_wound_coils:
  c_dual_wound:
    hold_coil: c_hold
    main_coil: c_power

diverters:
  d_test_dual_wound:
    activation_coil: c_dual_wound
    activation_switches: s_diverter
    type: hold
    feeder_devices: test_trough
    targets_when_active: playfield
    targets_when_inactive: test_target
    debug: True
```

Listing 22.95: `your_machine_folder/config/test_diverter_with_switch.yaml`

```
#config_version=4

diverters:
  d_test:
    activation_coil: c_diverter
    type: hold
    debug: True
    activation_switches: s_activate
    deactivation_switches: s_deactivate
```



```

        disable_switches: s_disable

coils:
  c_diverter:
    number: 10

switches:
  s_activate:
    number: 1
  s_disable:
    number: 2
  s_deactivate:
    number: 3

```

Listing 22.96: `your_machine_folder/config/test_eject_to_oposide_sides.yaml`

```

#config_version=4

config:
- config.yaml

diverters:
  d_test_hold:
    activation_coil: c_diverter
    type: hold
    feeder_devices: test_trough, test_trough2
    targets_when_active: playfield
    targets_when_inactive: test_target
    debug: True

coils:
  eject_coil3:
    number: 10

switches:
  s_ball_switch3:
    number: 10
  s_ball_switch4:
    number: 11

ball_devices:
  test_trough2:
    eject_coil: eject_coil3
    ball_switches: s_ball_switch3, s_ball_switch4
    confirm_eject_type: target
    eject_targets: test_target, playfield
    tags: trough, drain, home

virtual_platform_start_active_switches:
- s_ball_switch3
- s_ball_switch4

```


Listing 22.97: `your_machine_folder/config/test_hold_activation_time.yaml`

```
#config_version=4

config:
- config.yaml

diverters:
  d_test_hold_activation_time:
    activation_coil: c_diverter
    activation_switches: s_diverter
    type: hold
    feeder_devices: test_trough
    targets_when_active: playfield
    targets_when_inactive: test_target
    activation_time: 4s
    debug: True
```

Listing 22.98: `your_machine_folder/config/test_hold_no_activation_time.yaml`

```
#config_version=4

config:
- config.yaml

diverters:
  d_test_hold:
    activation_coil: c_diverter
    activation_switches: s_diverter
    type: hold
    feeder_devices: test_trough
    targets_when_active: playfield
    targets_when_inactive: test_target
    debug: True
```


Listing 22.99: `your_machine_folder/config/test_pulsed_activation_time.yaml`

```
#config_version=4

config:
- config.yaml

diverters:
  d_test_pulse:
    activation_coil: c_diverter
    deactivation_coil: c_diverter_disable
    type: pulse
    feeder_devices: test_trough
    targets_when_active: playfield
    targets_when_inactive: test_target
    debug: True
```

dmd (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Note that there are multiple machine config examples here. They're just included to show different options. You wouldn't actually use more than one.

Listing 22.100: `your_machine_folder/config/test_color_dmd.yaml`

```
#config_version=4

displays:
  default:
    width: 800
    height: 600
  dmd:
    width: 128
    height: 32

slides:
  slide1:
    - type: color_dmd
      width: 640
      height: 160
      # color: ffcccc
      # source_display: dmd
      # shades: 4
      # gain: 2
    - type: text
      text: COLOR DMD TEST
      y: 200
    - type: rectangle
      width: 642
```



```
    height: 162
    color: gray
dmd_slide:
- type: text
  text: DMD TEXT
  anchor_x: center
  x: 128
  animations:
    show_slide:
      - property: x
        value: 10%
        duration: .25s
      - property: x
        value: 35%
        repeat: true
        duration: 250ms
- type: rectangle
  width: 8
  height: 32
  color: red
  x: 4
- type: rectangle
  width: 8
  height: 32
  color: orange
  x: 12
- type: rectangle
  width: 8
  height: 32
  color: yellow
  x: 20
- type: rectangle
  width: 8
  height: 32
  color: green
  x: 28
- type: rectangle
  width: 8
  height: 32
  color: blue
  x: 36
- type: rectangle
  width: 8
  height: 32
  color: purple
  x: 44
- type: rectangle
  width: 8
  height: 32
  color: pink
  x: 52
- type: rectangle
  width: 8
  height: 32
  color: dddddd
```



```
  x: 60
- type: rectangle
  width: 8
  height: 32
  color: bbbbbb
  x: 68
- type: rectangle
  width: 8
  height: 32
  color: 888888
  x: 76
- type: rectangle
  width: 8
  height: 32
  color: 666666
  x: 84
- type: rectangle
  width: 8
  height: 32
  color: 444444
  x: 92
- type: rectangle
  width: 8
  height: 32
  color: 333333
  x: 100
- type: rectangle
  width: 8
  height: 32
  color: 222222
  x: 108
- type: rectangle
  width: 8
  height: 32
  color: 111111
  x: 116
- type: rectangle
  width: 8
  height: 32
  color: 000000
  x: 124

slide_player:
  slide1: slide1
  dmd_slide:
    dmd_slide:
      target: dmd
```

Listing 22.101: [your_machine_folder/config/test_dmd.yaml](#)

```
#config_version=4

displays:
  default:
    width: 800
```



```
    height: 600
dmd:
  width: 128
  height: 32
widgets:
  right_dmd_widget:
    type: text
    text: "Right Widget"
    x: right
  left_dmd_widget:
    type: text
    text: "Left Widget"
    x: left
  top_dmd_widget:
    type: text
    text: "Top Widget"
    y: 100%
  bottom_dmd_widget:
    type: text
    text: "Bottom Widget"
    y: 0%
slides:
  container_slide:
    - type: dmd
      width: 640
      height: 160
    #   color: ff00aa
    #   source_display: dmd
    #   shades: 16
    #   gain: 2
    #   bg_color: 303030
    #   blur: .5
    #   pixel_size: .7
    #   dot_filter: false
    - type: text
      text: TRADITIONAL DMD TEST
      y: 200
    - type: rectangle
      width: 642
      height: 162
      color: gray
  dmd_slide:
    - type: text
      text: DMD TEXT
      anchor_x: center
      x: 128
      animations:
        show_slide:
          - property: x
            value: 10%
            duration: .25s
          - property: x
            value: 35%
            repeat: true
            duration: 250ms
```



```
- type: rectangle
  width: 8
  height: 32
  color: fffffff
  x: 4
- type: rectangle
  width: 8
  height: 32
  color: eeeeeee
  x: 12
- type: rectangle
  width: 8
  height: 32
  color: ddddddd
  x: 20
- type: rectangle
  width: 8
  height: 32
  color: ccccccc
  x: 28
- type: rectangle
  width: 8
  height: 32
  color: bbbbbbb
  x: 36
- type: rectangle
  width: 8
  height: 32
  color: aaaaaaa
  x: 44
- type: rectangle
  width: 8
  height: 32
  color: 9999999
  x: 52
- type: rectangle
  width: 8
  height: 32
  color: 8888888
  x: 60
- type: rectangle
  width: 8
  height: 32
  color: 7777777
  x: 68
- type: rectangle
  width: 8
  height: 32
  color: 6666666
  x: 76
- type: rectangle
  width: 8
  height: 32
  color: 5555555
  x: 84
```



```
- type: rectangle
  width: 8
  height: 32
  color: 444444
  x: 92
- type: rectangle
  width: 8
  height: 32
  color: 333333
  x: 100
- type: rectangle
  width: 8
  height: 32
  color: 222222
  x: 108
- type: rectangle
  width: 8
  height: 32
  color: 111111
  x: 116
- type: rectangle
  width: 8
  height: 32
  color: 000000
  x: 124

slide_player:
  container_slide: container_slide
  dmd_slide:
    dmd_slide:
      target: dmd

widget_player:
  position_widget_right:
    right_dmd_widget:
      target: dmd
  position_widget_left:
    left_dmd_widget:
      target: dmd
  position_widget_top:
    top_dmd_widget:
      target: dmd
  position_widget_bottom:
    bottom_dmd_widget:
      target: dmd
```

drop_targets (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.102: `your_machine_folder/config/test_drop_targets.yaml`

```
#config_version=4
```

```
switches:
```

```
  switch1:
```

```
    number:
```

```
  switch2:
```

```
    number:
```

```
  switch3:
```

```
    number:
```

```
  switch4:
```

```
    number:
```

```
  switch5:
```

```
    number:
```

```
  switch6:
```

```
    number:
```

```
  switch7:
```

```
    number:
```

```
  switch8:
```

```
    number:
```

```
  switch9:
```

```
    number:
```

```
  switch10:
```

```
    number:
```

```
  switch11:
```

```
    number:
```

```
coils:
```

```
  coil1:
```

```
    number:
```

```
  coil2:
```

```
    number:
```

```
  coil3:
```

```
    number:
```

```
  coil4:
```

```
    number:
```

```
    hold_power: 2
```

```
  coil5:
```

```
    number:
```

```
  coil6:
```

```
    number:
```

```
  coil7:
```

```
    number:
```

```
modes:
```

```
  - mode1
```

```
drop_targets:
```

```
  left1:
```

```
    debug: True
```

```
    switch: switch1
```

```
  left2:
```

```
    debug: True
```

```
    switch: switch2
```



```
left3:
  debug: True
  switch: switch3
left4:
  debug: True
  switch: switch4
left5:
  debug: True
  switch: switch5
left6:
  debug: True
  switch: switch6
  reset_coil: coil2
  knockdown_coil: coil3
  knockdown_events: knock_knock
  reset_events: reset_target
drop_target_lock:
  debug: True
  reset_coil: coil4
  switch: switch7
  enable_keep_up_events: keep_up
  disable_keep_up_events: no_more_keep_up
right1:
  switch: switch8
right2:
  switch: switch9
center1:
  switch: switch10
  ignore_switch_ms: 1000
  reset_events: reset_center1
  reset_coil: coil6
  knockdown_coil: coil7
  knockdown_events: knockdown_center1

drop_target_banks:
  left_bank:
    debug: True
    drop_targets: left1, left2, left3
    reset_coils: coil1
    reset_events:
      drop_target_bank_left_bank_down: 1s
  right_bank:
    drop_targets: right1, right2
    reset_coils: coil5
    ignore_switch_ms: 1000
    reset_events: reset_right_bank
```

Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Listing 22.103: `your_machine_folder/modes/model/config/model1.yaml`

```
#config_version=4

mode:
  priority: 100
  game_mode: False

drop_target_banks:
  left_bank_2:
    drop_targets: left4, left5, left6
    reset_coils: coil2
    reset_on_complete: 1s
```

event_manager (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.104: `your_machine_folder/config/test_event_manager.yaml`

```
#config_version=4

bcp:
  connections:
    local_display:
      connection_attempts: 0

event_player:
  test_event_player1:
    - test_event_player2
    - test_event_player3
  test_event_player_delayed:
    - test_event_player2|2s
    - test_event_player3:2s

random_event_player:
  test_random_event_player1:
    events:
      - test_random_event_player2
      - test_random_event_player3
    scope: machine

modes:
  - test_mode
```

Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Listing 22.105: `your_machine_folder/modes/test_mode/config/test_mode.yaml`

```
#config_version=4
mode:
  start_events: test_mode_start
  stop_events: test_mode_end
  game_mode: False

event_player:
  test_event_player_mode1:
    test_event_player_mode2
    test_event_player_mode3

random_event_player:
  test_random_event_player_model:
    - test_random_event_player_mode2
    - test_random_event_player_mode3
  test_random_event_player_weighted:
    scope: machine
    force_different: False
    force_all: False
  events:
    out3: 1
    out4: 1000
```

event_players (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Note that there are multiple machine config examples here. They're just included to show different options. You wouldn't actually use more than one.

Listing 22.106: `your_machine_folder/config/test_event_player.yaml`

```
#config_version=4

modes:
  - mode1

event_player:
  play_express_single: event1
  play_express_multiple: event1, event2
  play_single_list:
    - event1
  play_single_string:
    event1
  play_multiple_list:
    - event1
    - event2
    - event3
```



```

play_multiple_string:
  event1
  event2
  event3
play_multiple_args:
  event1: {"a": "b"}
  event2: {}
  event3: {"a": 1, "b": 2}
test_conditional{arg.abc==1}: condition_ok
test_conditional.2{arg.abc==1}: condition_ok2
test_conditional.3: priority_ok
test_time_delay1: td1|1500ms
test_time_delay2: td2|1.5s
test_conditional_mode{mode.mode1.active}: mode1_active
test_conditional_mode{not mode.mode1.active}: mode1_not_active

shows:
  test_event_show:
    - events:
      - event1
      - event2
      - event3

```

Listing 22.107: `your_machine_folder/config/test_queue_event_player.yaml`

```

#config_version=4

modes:
  - mode1

queue_event_player:
  play:
    queue_event: queue_event1
    events_when_finished: queue_event1_finished

queue_relay_player:
  relay.1:
    post: relay_start
    wait_for: relay_done
  relay:
    post: relay2_start
    wait_for: relay2_done

```

Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Listing 22.108: `your_machine_folder/modes/mode1/config/mode1.yaml`

```

#config_version=4
mode:
  game_mode: False

queue_relay_player:

```



```
relay3:
  post: relay3_start
  wait_for: relay3_done
```

extra_ball (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Note that there are multiple machine config examples here. They're just included to show different options. You wouldn't actually use more than one.

Listing 22.109: `your_machine_folder/config/config.yaml`

```
#config_version=4

modes:
  - model

game:
  balls_per_game: 1

coils:
  eject_coil1:
    number:
  eject_coil2:
    number:

switches:
  s_start:
    number:
    tags: start
  s_ball_switch1:
    number:
  s_ball_switch2:
    number:
  s_ball_switch_launcher:
    number:

ball_devices:
  bd_trough:
    eject_coil: eject_coil1
    ball_switches: s_ball_switch1, s_ball_switch2
    debug: true
    confirm_eject_type: target
    eject_targets: bd_launcher
    tags: trough, drain, home
  bd_launcher:
    eject_coil: eject_coil2
    ball_switches: s_ball_switch_launcher
    debug: true
```



```
confirm_eject_type: target
eject_timeouts: 2s
tags: ball_add_live
```

Listing 22.110: `your_machine_folder/config/disabled.yaml`

```
#config_version=4

modes:
  - mode1

game:
  balls_per_game: 1

coils:
  eject_coil1:
    number:
  eject_coil2:
    number:

global_extra_ball_settings:
  enabled: no

switches:
  s_start:
    number:
    tags: start
  s_ball_switch1:
    number:
  s_ball_switch2:
    number:
  s_ball_switch_launcher:
    number:

ball_devices:
  bd_trough:
    eject_coil: eject_coil1
    ball_switches: s_ball_switch1, s_ball_switch2
    debug: true
    confirm_eject_type: target
    eject_targets: bd_launcher
    tags: trough, drain, home
  bd_launcher:
    eject_coil: eject_coil2
    ball_switches: s_ball_switch_launcher
    debug: true
    confirm_eject_type: target
    eject_timeouts: 2s
    tags: ball_add_live
```

Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Listing 22.111: `your_machine_folder/modes/model/config/model.yaml`

```
#config_version=4
mode:
  start_events: start_model
  stop_events: stop_model

extra_balls:
  test_extra_ball:
    award_events: extra_ball_award
    reset_events: extra_ball_reset
```

fast (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.112: `your_machine_folder/config/config.yaml`

```
#config_version=4

hardware:
  platform: fast
  driverboards: fast

fast:
  ports: com4, com5, com6
  debug: true

switches:
  s_test:
    number: 7
    debounce_open: 1A
    debounce_close: 5
  s_test_nc:
    number: 1A
    type: 'NC'
  s_slingshot_test:
    number: 16
  s_flipper:
    number: 1
  s_flipper_eos:
    number: 2
  s_autofire:
    number: 3
  s_test3:
    number: 3-1

coils:
  c_test:
    number: 4
```



```
    pulse_ms: 23
c_test_allow_enable:
  number: 6
  pulse_ms: 23
  allow_enable: true
c_slingshot_test:
  number: 7
c_pulse_pwm_mask:
  number: 10
  pulse_pwm_mask: 10001001
  hold_pwm_mask: 10101010
c_pulse_pwm32_mask:
  number: 11
  pulse_pwm_mask: 10001001100010011000100110001001
  hold_pwm_mask: 10101010100010011010101010001001
c_long_pulse:
  number: 12
  pulse_ms: 2000
  allow_enable: true
c_flipper_main:
  number: 20
  pulse_ms: 10
  hold_power: 1
c_flipper_hold:
  number: 3-5
  hold_power: 1

autofire_coils:
  ac_slingshot_test:
    coil: c_slingshot_test
    switch: s_slingshot_test
  ac_inverted_switch:
    coil: c_slingshot_test
    switch: s_test_nc
  ac_same_switch1:
    coil: c_test
    switch: s_autofire
    enable_events: ac_same_switch
  ac_same_switch2:
    coil: c_test_allow_enable
    switch: s_autofire
    enable_events: ac_same_switch
  ac_broken_combination:
    coil: c_flipper_hold
    switch: s_slingshot_test
  ac_different_boards:
    coil: c_flipper_hold
    switch: s_test
  ac_board_3:
    coil: c_flipper_hold
    switch: s_test3

servos:
  serv01:
    number: 3
```



```
flippers:
  f_test_single:
    debug: true
    main_coil_overwrite:
      pulse_ms: 11
    main_coil: c_flipper_main
    activation_switch: s_flipper

  f_test_hold:
    debug: true
    main_coil: c_flipper_main
    hold_coil: c_flipper_hold
    activation_switch: s_flipper

  f_test_hold_eos:
    debug: true
    main_coil: c_flipper_main
    hold_coil: c_flipper_hold
    activation_switch: s_flipper
    eos_switch: s_flipper_eos
    use_eos: true

matrix_lights:
  test_pdb_light:
    number: 23

gis:
  test_gi:
    number: 2A

leds:
  test_led:
    number: 2-23
  test_led2:
    number: 2-25
```

flippers (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Note that there are multiple machine config examples here. They're just included to show different options. You wouldn't actually use more than one.

Listing 22.113: [your_machine_folder/config/config.yaml](#)

```
#config_version=4

game:
  balls_per_game: 1
```



```
coils:
  c_flipper_main:
    number:
      pulse_ms: 10
  c_flipper_hold:
    number:
      hold_power: 1

switches:
  s_flipper:
    number: 1
    tags: left_flipper
  s_flipper_eos:
    number: 2

flippers:
  f_test_single:
    debug: true
    main_coil: c_flipper_main
    activation_switch: s_flipper

  f_test_hold:
    debug: true
    main_coil: c_flipper_main
    hold_coil: c_flipper_hold
    activation_switch: s_flipper

  f_test_hold_eos:
    debug: true
    main_coil: c_flipper_main
    hold_coil: c_flipper_hold
    activation_switch: s_flipper
    eos_switch: s_flipper_eos
    use_eos: true

  f_test_flippers_with_settings:
    debug: true
    main_coil: c_flipper_main
    power_setting_name: flipper_power
    activation_switch: s_flipper
```

Listing 22.114: `your_machine_folder/config/hold_no_eos.yaml`

```
#config_version=4

hardware:
  platform: fast
  driverboards: fast

switches:
  s_left_flipper:
    number: 0-0
    tags: left_flipper
```



```

s_right_flipper:
  number: 0~1
  tags: right_flipper

coils:
  c_flipper_left_main:
    number: 0~0
    pulse_ms: 30
  c_flipper_left_hold:
    number: 0~1
    allow_enable: true
  c_flipper_right_main:
    number: 0~2
    pulse_ms: 30
  c_flipper_right_hold:
    number: 0~3
    allow_enable: true

flippers:
  left_flipper:
    main_coil: c_flipper_left_main
    hold_coil: c_flipper_left_hold
    activation_switch: s_left_flipper
    enable_events: machine_reset_phase_3
  right_flipper:
    main_coil: c_flipper_right_main
    hold_coil: c_flipper_right_hold
    activation_switch: s_right_flipper
    enable_events: machine_reset_phase_3

```

fonts (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.115: `your_machine_folder/config/built_in_dmd_fonts.yaml`

```

#config_version=4

displays:
  window:
    width: 800
    height: 600
  dmd:
    width: 128
    height: 32
    default: yes

slides:
  window:
    - type: dmd

```



```
    width: 640
    height: 160
  - type: text
    text: DMD FONT & POSITIONING TEST
    font_size: 50
    y: 410
  - type: rectangle
    width: 642
    height: 162
    color: gray
dmd_small:
  - type: text
    style: dmd_small
    text: DMD_SMALL
    anchor_y: top
    y: top
  - type: text
    style: dmd_small
    text: DMD_SMALL
    anchor_y: bottom
    y: bottom
dmd_med:
  - type: text
    style: dmd_med
    text: DMD_MED
    anchor_y: top
    y: top
  - type: text
    style: dmd_med
    text: DMD_MED
    anchor_y: bottom
    y: bottom
dmd_big:
  - type: text
    style: dmd_big
    text: DMD_BIG
    anchor_y: top
    y: top
  - type: text
    style: dmd_big
    text: DMD_BIG
    anchor_y: bottom
    y: bottom
slide_player:
  window_slide:
    window:
      target: window
  dmd_small: dmd_small
  dmd_med: dmd_med
  dmd_big: dmd_big
```


game (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.116: `your_machine_folder/config/config.yaml`

```
#config_version=4

game:
  balls_per_game: 3

coils:
  eject_coil1:
    number:
  eject_coil2:
    number:

switches:
  s_start:
    number:
    tags: start
  s_ball_switch1:
    number:
  s_ball_switch2:
    number:
  s_ball_switch_launcher:
    number:

ball_devices:
  bd_trough:
    eject_coil: eject_coil1
    ball_switches: s_ball_switch1, s_ball_switch2
    debug: true
    confirm_eject_type: target
    eject_targets: bd_launcher
    tags: trough, drain, home
  bd_launcher:
    eject_coil: eject_coil2
    ball_switches: s_ball_switch_launcher
    debug: true
    confirm_eject_type: target
    eject_timeouts: 2s
    tags: ball_add_live
```


head2head (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.117: `your_machine_folder/config/config.yaml`

```
#config_version=4

playfields:
  playfield:    # remove default playfield
    _delete: True
  playfield_front:
    label: Playfield Front
  playfield_back:
    label: Playfield Back

switches:
  s_trough1_front:
    number:
  s_trough2_front:
    number:
  s_trough3_front:
    number:
  s_trough4_front:
    number:
  s_trough1_back:
    number:
  s_trough2_back:
    number:
  s_trough3_back:
    number:
  s_trough4_back:
    number:
  s_launcher_lane_front:
    number:
  s_launcher_lane_back:
    number:
  s_middle_front1:
    number:
  s_middle_back1:
    number:
  s_feeder_front:
    number:
  s_feeder_back:
    number:
  s_launcher_diverter_front:
    number:
  s_launcher_diverter_back:
    number:
  s_transfer_front_back:
    number:
  s_transfer_back_front:
```



```

    number:
s_playfield_front:
    number:
    tags: playfield_front_active
s_playfield_back:
    number:
    tags: playfield_back_active

coils:
c_trough_eject_front:
    number:
c_trough_eject_back:
    number:
c_launcher_eject_front:
    number:
c_launcher_eject_back:
    number:
c_lock_figur_front:
    number:
c_lock_figur_back:
    number:
c_feeder_front:
    number:
c_feeder_back:
    number:

ball_devices:
bd_trough_front:
    ball_switches: s_trough1_front, s_trough2_front, s_trough3_front, s_trough4_front
    eject_coil: c_trough_eject_front
    eject_targets: bd_launcher_front
    tags: trough, home, drain
    captures_from: playfield_front
    ball_missing_target: playfield_front
    debug: true
bd_trough_back:
    ball_switches: s_trough1_back, s_trough2_back, s_trough3_back, s_trough4_back
    eject_coil: c_trough_eject_back
    eject_targets: bd_launcher_back
    tags: trough, home, drain
    captures_from: playfield_back
    ball_missing_target: playfield_back
    debug: true
bd_launcher_front:
    ball_switches: s_launcher_lane_front
    confirm_eject_type: switch
    confirm_eject_switch: s_launcher_diverter_back
    eject_coil: c_launcher_eject_front
    eject_targets: bd_feeder_back, bd_trough_back
    captures_from: playfield_front
    ball_missing_target: playfield_back
    debug: true
bd_launcher_back:
    ball_switches: s_launcher_lane_back
    confirm_eject_type: switch

```



```
confirm_eject_switch: s_launcher_diverter_front
eject_coil: c_launcher_eject_back
eject_targets: bd_feeder_front, bd_trough_front
captures_from: playfield_back
ball_missing_target: playfield_front
debug: true
bd_middle_front:
  hold_switches: s_middle_front1
  ball_switches: s_middle_front1
  confirm_eject_type: target
  hold_coil: c_lock_figur_front
  eject_targets: playfield_front
  captures_from: playfield_back
  ball_missing_target: playfield_front
  target_on_unexpected_ball: playfield_front
  debug: true
bd_middle_back:
  hold_switches: s_middle_back1
  ball_switches: s_middle_back1
  confirm_eject_type: target
  hold_coil: c_lock_figur_back
  eject_targets: playfield_back
  captures_from: playfield_front
  ball_missing_target: playfield_back
  target_on_unexpected_ball: playfield_back
  debug: true
bd_feeder_front:
  ball_switches: s_feeder_front
  hold_switches: s_feeder_front
  hold_coil: c_feeder_front
  eject_targets: playfield_front
  captures_from: playfield_front
  ball_missing_target: playfield_front
  eject_timeouts: 2s
  tags: ball_add_live
  debug: true
bd_feeder_back:
  ball_switches: s_feeder_back
  hold_switches: s_feeder_back
  hold_coil: c_feeder_back
  eject_targets: playfield_back
  captures_from: playfield_back
  ball_missing_target: playfield_back
  eject_timeouts: 2s
  tags: ball_add_live
  debug: true
playfield_transfers:
  transfer_front_back:
    ball_switch: s_transfer_front_back
    captures_from: playfield_front
    eject_target: playfield_back
  transfer_back_front:
    ball_switch: s_transfer_back_front
    captures_from: playfield_back
```



```
eject_target: playfield_front
```

high_score (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.118: `your_machine_folder/config/high_score.yaml`

```
# config_version=4

modes:
  - high_score
```

Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Listing 22.119: `your_machine_folder/modes/high_score/config/high_score.yaml`

```
#config_version=4
high_score:
  _overwrite: True
  categories:
    - score:
        - GRAND CHAMPION
        - HIGH SCORE 1
        - HIGH SCORE 2
        - HIGH SCORE 3
        - HIGH SCORE 4
    - loops:
        - LOOP CHAMP
  defaults:
    score:
      - BRI: 4242
      - GHK: 2323
      - JK: 1337
      - QC: 42
      - MPF: 23
    loops:
      - JK: 42
```


info_lights (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.120: `your_machine_folder/config/config.yaml`

```
#config_version=4

machine:
  min_balls: 0

switches:
  s_start:
    number: 1
    tags: start

matrix_lights:
  match00:
    number:
  match10:
    number:
  match20:
    number:
  match30:
    number:
  match40:
    number:
  match50:
    number:
  match60:
    number:
  match70:
    number:
  match80:
    number:
  match90:
    number:
  bip1:
    number:
  bip2:
    number:
  bip3:
    number:
  player1:
    number:
  player2:
    number:

leds:
  tilt:
    number:
  gameOver:
```



```
        number:
info_lights:
  match_00:
    light: match00
  match_10:
    light: match10
  match_20:
    light: match20
  match_30:
    light: match30
  match_40:
    light: match40
  match_50:
    light: match50
  match_60:
    light: match60
  match_70:
    light: match70
  match_80:
    light: match80
  match_90:
    light: match90
  ball_1:
    light: bip1
  ball_2:
    light: bip2
  ball_3:
    light: bip3
  player_1:
    light: player1
  player_2:
    light: player2
  tilt:
    light: tilt
  game_over:
    light: gameOver
```

keyboard (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.121: `your_machine_folder/config/test_keyboard.yaml`

```
#config_version=4
keyboard:
  a:
    switch: switch_a
  b:
    switch: switch_b
```



```
toggle: true
c:
  switch: switch_c
  invert: true
d:
  event: event_d
e:
  event: event_e
  params:
    foo: bar
    mission: pinball
f:
  mc_event: event_f
g:
  mc_event: event_g
  params:
    foo: bar
    mission: pinball
shift-a:
  switch: shift_a
shift+b:
  switch: shift_b
shift-ctrl-c:
  switch: shift_ctrl_c
1:
  switch: switch_1
.:
  switch: switch_period
/:
  switch: switch_slash
```

kickback (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.122: [your_machine_folder/config/config.yaml](#)

```
#config_version=4

coils:
  kickback_coil:
    number:
    pulse_ms: 100

switches:
  s_kickback:
    number:

kickbacks:
  kickback_test:
```



```
coil: kickback_coil
switch: s_kickback
enable_events: kickback_enable
disable_events: kickback_kickback_test_fired

ball_saves:
  kickback_save:
    balls_to_save: 1
    active_time: 5s
    enable_events: kickback_kickback_test_fired
```

led (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Note that there are multiple machine config examples here. They're just included to show different options. You wouldn't actually use more than one.

Listing 22.123: `your_machine_folder/config/led.yaml`

```
#config_version=4

led_settings:
  color_correction_profiles:
    correction_profile_1:
      gamma: 1
      whitepoint: [0.9, 0.8, 0.7]
      linear_slope: 0.75
      linear_cutoff: 0.1

leds:
  led1:
    number: 1
    debug: True
  led2:
    number: 2, 3, 4
    type: bgr
    debug: True
  led3:
    number: 7, 8, 9, 10
    type: rgbw
    debug: True
  led4:
    number: 11
    fade_ms: 1s
  led5:
    number: 12, 13, 14
    type: w+-
    debug: True
led_lights:
```



```
    number: light_r, light_g, light_b
    platform: lights
  led_corrected:
    number:
    color_correction_profile: correction_profile_1

matrix_lights:
  light_r:
    number: 2
  light_g:
    number: 3
  light_b:
    number: 4
```

Listing 22.124: `your_machine_folder/config/led_groups.yaml`

```
#config_version=4

led_stripes:
  stripe1:
    number_start: 10
    led_template:
      tags: test
    count: 5
    debug: True
  stripe2:
    number_start: 200
    number_template: 7-{}
    count: 5
    direction: 90
    start_x: 10
    start_y: 20
    distance: 5
    debug: True

led_rings:
  ring1:
    number_start: 20
    count: 12
    radius: 3
    start_angle: 90
    center_x: 100
    center_y: 50
    debug: True
```

led_player (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.125: `your_machine_folder/config/led_player.yaml`

```
#config_version=4

modes:
  - mode1

leds:
  led1:
    debug: True
    number:
    tags: tag1
  led2:
    debug: True
    number:
    tags: tag1
  led3:
    debug: True
    number:
    tags:
  led4:
    debug: True
    number:
    tags:
  led5:
    debug: True
    number:
    default_color: red

led_player:
  event1:
    led1:
      color: red
      fade: 0
      priority: 200
    led2:
      color: ff0000
      fade: 0
    led3:
      color: red
      fade: 0
  event2:
    tag1:
      color: blue
      fade: 200ms
      priority: 100
  event3:
    led1: lime-f500
    led2: lime - f 500ms
    led3: 00ff00-f.5s
  event4:
    tag1: 00ffff
  event5:
    led5: on
```



```
shows:
  show1:
    - time: 0
      leds:
        led1: red
        led2: red
        led3: red
  show2:
    - time: 0
      leds:
        led1: red
        led2: red
        led3: red
    - time: 1
  show3:
    - time: 0
      leds:
        led1: blue
        led2: blue
        led3: blue
    - time: 1
  show2_stay_on:
    - time: 0
      duration: -1
      leds:
        led1: red
        led2: red
        led3: red
```

Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Listing 22.126: `your_machine_folder/modes/model/config/model1.yaml`

```
# config_version=4

mode:
  priority: 100
  game_mode: False

led_player:
  event5:
    led1:
      color: orange
    led2:
      color: orange
    led3:
      color: orange
      priority: 200
```

logic_blocks (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.127: `your_machine_folder/config/config.yaml`

```
#config_version=4

leds:
  led1:
    number:
  led2:
    number:
  led3:
    number:

# system wide logic blocks
logic_blocks:
  accruals:
    accrual1:
      events:
        - accrual1_step1a, accrual1_step1b, accrual1_step1c
        - accrual1_step2a, accrual1_step2b, accrual1_step2c
        - accrual1_step3a, accrual1_step3b, accrual1_step3c
      events_when_complete: accrual1_complete1, accrual1_complete2
      enable_events: accrual1_enable
      disable_events: accrual1_disable
      reset_events: accrual1_reset
      events_when_hit: accrual1_hit
    accrual2:
      events:
```



```

        - accrual2_step1
        - accrual2_step2
accrual3:
  events:
    - accrual3_step1
    - accrual3_step2
  reset_on_complete: False
  disable_on_complete: True
  enable_events: accrual3_enable
  disable_events: accrual3_disable
  reset_events: accrual3_reset
accrual4:
  events:
    - accrual4_step1
    - accrual4_step2
  reset_on_complete: False
  disable_on_complete: False
  enable_events: accrual4_enable
  disable_events: accrual4_disable
  reset_events: accrual4_reset
accrual5:
  events:
    - accrual5_step1
    - accrual5_step2
  persist_state: True
counters:
  counter1:
    count_events: counter1_count
    starting_count: 5
    count_complete_value: 0
    direction: down
    enable_events: counter1_enable
    disable_events: counter1_disable
    restart_events: counter1_restart
    reset_events: counter1_reset
  counter3:
    count_events: counter3_count
    starting_count: 0
    count_complete_value: 5
    count_interval: -1
    direction: up
    enable_events: counter3_enable
    disable_events: counter3_disable
    restart_events: counter3_restart
    reset_events: counter3_reset
    multiple_hit_window: 1s
  counter4:
    count_events: counter4_count
    starting_count: machine.start if machine.start else 0
    count_complete_value: current_player.hits
    direction: up
    enable_events: counter4_enable
    disable_events: counter4_disable
    restart_events: counter4_restart
    reset_events: counter4_reset

```



```

    counter5:
      count_events: counter5_count
  sequences:
    sequence1:
      events:
        - sequence1_step1a, sequence1_step1b
        - sequence1_step2a, sequence1_step2b
        - sequence1_step3a, sequence1_step3b
      events_when_complete: sequence1_complete
      enable_events: sequence1_enable
      disable_events: sequence1_disable
      reset_events: sequence1_reset

# logic blocks in mode1
modes:
  - mode1
  - mode2

```

Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Note that there are multiple mode config examples here. You might not necessarily use more than one in your machine.

Listing 22.128: `your_machine_folder/modes/mode1/config/mode1.yaml`

```

#config_version=4
mode:
  start_events: start_mode1
  stop_events: stop_mode1

logic_blocks:
  counters:
    counter2:
      count_events: counter2_count
      events_when_hit: counter2_hit
      events_when_complete: counter2_complete
      starting_count: 0
      count_complete_value: 3
      direction: up
      reset_on_complete: True
      disable_on_complete: False
    counter_persist:
      count_events: counter_persist_count
      enable_events: counter_persist_enable
      direction: down
      starting_count: 5
      count_complete_value: 0
      persist_state: true

```


Listing 22.129: `your_machine_folder/modes/mode2/config/mode2.yaml`

```
#config_version=4
mode:
  start_events: start_mode2
  stop_events: stop_mode2

logic_blocks:
  counters:
    counter_with_lights:
      count_events: counter_with_lights_count
      enable_events: counter_with_lights_enable
      starting_count: 0
      count_complete_value: 3
      direction: up
      persist_state: True

show_player:
  logicblock_counter_with_lights_updated:
    counter_show:
      start_step: current_player.counter_with_lights_count + 1

shows:
  counter_show:
    - duration: -1
      leds:
        led1: on
    - duration: -1
      leds:
        led2: on
    - duration: -1
      leds:
        led3: on
```

magnet (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.130: `your_machine_folder/config/config.yaml`

```
#config_version=4

coils:
  magnet_coil1:
    number:
    pulse_ms: 100
    hold_power: 3
  magnet_coil2:
    number:
    pulse_ms: 100
```



```

    hold_power: 3

switches:
  grab_switch1:
    number:
  grab_switch2:
    number:

magnets:
  magnet1:
    magnet_coil: magnet_coil1
    grab_switch: grab_switch1
    enable_events: magnet1_enable
    disable_events: magnet1_disable
    release_ball_events: magnet1_release
    fling_ball_events: magnet1_fling

  magnet_ball_save:
    magnet_coil: magnet_coil2
    grab_switch: grab_switch2
    enable_events: magnet_ball_save_enable
    disable_events: magnet_magnet_ball_save_grabbed_ball
    fling_ball_events: magnet_magnet_ball_save_grabbed_ball

ball_saves:
  magnet_save:
    balls_to_save: 1
    active_time: 5s
    enable_events: magnet_magnet_ball_save_grabbing_ball

```

migrator (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Note that there are multiple machine config examples here. They're just included to show different options. You wouldn't actually use more than one.

Listing 22.131: `your_machine_folder/config/test_config1_v4.yaml`

```

#config_version=4
# test_config1

game:
  allow_start_with_loose_balls: true

switches:
  s_left_rollover:
    number: 0
    events_when_activated: event1
    events_when_deactivated: event2

```



```
    debounce: normal
s_center_rollover:
    number: L12
    debounce: normal
s_2:
    number:
    debounce: quick
s_3:
    number:
    debounce: quick
matrix_lights:
    l_fortress_multiball:
        number:
    l_museum_multiball:
        number:
    l_wasteland_multiball:
        number:
    l_cryoprison_multiball:
        number:
    l_ball_save:
        number:
    l_super_jackpot:
        number:
    l_computer:
        number:
    l_demo_time:
        number:
    l_retina_scan:
        number:
leds:
    led1:
        number:
sound_system:
    tracks:
        voice:
            volume: 1
            priority: 2
            simultaneous_sounds: 1
            preload: true
        sfx:
            volume: 1
            priority: 1
            preload: true
            simultaneous_sounds: 7
        music:
            volume: 0.5
            simultaneous_sounds: 1
    buffer: 2048 # previous value was 512
    frequency: 44100
    channels: 1
    master_volume: 1
    enabled: true
physical_dmd:
    width: 128
```



```
    height: 32
    shades: 16
window:
    width: 600
    height: 200
    title: Mission Pinball Framework - Demo Man
    resizable: true
    fullscreen: false
    borderless: false
    exit_on_escape: true
slide_player:
    single_player_ball_started:
        slide_1:
            transition:
                type: move_out
                duration: 1s
                direction: top
    player_1_multiplayer_slide: slide_2
    test_with_movie:
        slide_3:
            expire: 5.1s
            priority: 20
    machine_reset_phase_3:
        window_slide_1:
            target: window
widget_styles:
    default:
        font_name: Quadrit
        font_size: 10
        adjust_top: 2
        adjust_bottom: 3
    space title huge:
        font_name: DEADJIM
        font_size: 29
        antialias: true
        adjust_top: 3
        adjust_bottom: 3
    medium:
        font_name: pixelmix
        font_size: 8
        adjust_top: 1
        adjust_bottom: 1
    small:
        font_name: smallest_pixel-7
        font_size: 9
        adjust_top: 2
        adjust_bottom: 3
    tall title:
        font_name: big_noodle_titling
        font_size: 20

    space title:
        font_name: DEADJIM
        font_size: 21
        antialias: true
```



```
    adjust_top: 2
    adjust_bottom: 3
sounds:
  intro_loop:
    file: waiting to plunge loop.ogg
    track: music
  slingshot:
    file: slingshot.ogg
    track: sfx
  ball_launch_motorcycle:
    file: ball launch motorcycle.ogg
    track: sfx
  main_loop:
    file: main song loop.wav

images:
  jackpot:
    file: jackpot1.jpg
videos:
  test_movie1:
    load: preload

assets:
  images:
    default:
      load: preload
    screen:
      load: preload
  sounds:
    default:
      track: sfx
      load: preload
    voice:
      track: voice
      load: preload
    sfx:
      track: sfx
      load: preload
    music:
      track: music
      load: preload
  shows:
    default:
      load: preload
  videos:
    default:
      load: preload

sound_player:
  ball_starting:
    intro_loop:
      duration:
      loops: -1
      priority:
      fade_in: 0
```



```
        fade_out: 0
ball_live_added:
    intro_loop:
        action: stop
sw_launch:
    ball_launch_motorcycle:
        action: play
    test_sound:
        action: play
shot_slingshot: slingshot
player_eject_request:
    main_loop:
        loops: -1
ball_ending:
    main_loop:
        action: stop
    test_sound:
        action: stop
mode_super_spinner_stopped:
    base_mode_music:
        loops: -1
mode_millions_stopped:
    base_mode_music:
        loops: -1
mode_skillshot_stopped:
    base_mode_music:
        loops: -1
mode_base_stopping:
    base_mode_music:
        action: stop
shot_profiles:
    hit_me:
        states:
            - name: active
              show: flash
              loops: -1
              speed: 5
            - name: complete
              show: off
        player_variable: laser
    default:
        states:
            - name: unlit
              show: off
            - name: lit
              show: on
    drop_shot:
        states:
            - name: up
              show: off
            - name: down
              show: on
shots:
    left_lane:
        switch: s_left_rollover
```



```

    show_tokens:
        light: l_left_rollover
middle_lane:
    switch: s_center_rollover
    show_tokens:
        light: l_middle_rollover
shot_groups:
    rollover_lanes:
        shots: left_lane, middle_lane
shows:
    flash:
        - time: 0
          lights:
              (lights): ff
        - time: '+1'
          lights:
              (lights): 0

        - time: '+1'
    flashon:
        - time: 0
          lights:
              (lights): ff
        - time: '+1'
          lights:
              (lights): 0
        - time: '+1'
          lights:
              (lights): ff

        - time: '+1'
    rainbow:
        - time: 0
          leds:
              (leds): red
        - time: '+1'
          leds:
              (leds): lime
        - time: '+1'
          leds:
              (leds): blue

        - time: '+1'
logic_blocks:
    counters:
        spinner_level:
            count_events: s_TelboySpinner_active
            starting_count: 0
            count_complete_value: 50
            direction: up
            events_when_complete: super_spinner_round
            player_variable: spins
            enable_events: mode_base_started, mode_super_spinner_stopped, start_round_counters

```



```

        disable_events: stop_round_counters
        disable_on_complete: true
        reset_events: mode_super_spinner_stopping
        persist_state: true
displays:
    window:
        height: 200
        width: 600
    dmd:
        width: 128
        height: 32
        default: true
slides:
    slide_1:
        - type: text
          text: (player1|score)
          number_grouping: true
          min_digits: 2
          y: middle+2 # -2
          #persist_slide: yes
          style: tall title
        - type: text
          text: BALL (player1|ball)      (machine|credits_string)
          anchor_y: bottom # bottom
          style: small
          y: bottom+1 # -1

    slide_2:
        - type: text
          text: (player1|score)
          #font: medium
          number_grouping: true
          min_digits: 2
          anchor_y: top
          anchor_x: right
          x: right-60
          y: top-2
        - type: text
          text: (player2|score)
          style: medium
          anchor_y: top # top
          anchor_x: right # right
          number_grouping: true
          min_digits: 2
          x: right-2 # -2
          y: top-2 # 2
        - type: text
          text: (player3|score)
          style: medium
          anchor_y: bottom # bottom
          anchor_x: right # right
          y: bottom+10 # -10
          x: right-60 # -60
          number_grouping: true
          min_digits: 2

```



```
- type: text
  text: (player4|score)
  style: medium
  anchor_y: bottom # bottom
  anchor_x: right # right
  y: bottom+10 # -10
  x: right-2 # -2
  number_grouping: true
  min_digits: 2
- type: text
  text: BALL (player1|ball)      (machine|credits_string)
  anchor_y: bottom # bottom
  style: small
  y: bottom+1 # -1
slide_3:
- type: video
  video: my_movie
  z: 1
window_slide_1:
- type: dmd
  width: 512
  height: 128
  pixel_color: ff5500
  dark_color: 220000
  z: 1
- type: text
  style: tall title
  text: MISSION PINBALL FRAMEWORK
  anchor_y: top # top
  y: top-3 # 3
  font_size: 30
  z: 1
  color: white

- type: rectangle
  width: 514
  height: 130
  z: 2
  color: 444444

- type: image
  image: test_animation
  fps: 10
  loops: -1
  auto_play: true

- type: line
  width: 100
  height: 100
  z: 2
  points:
    - 0
    - 0
    - 100
    - 100
```



```

-   type: text
    style: tall title
    text: DEMO MAN
    anchor_x: right # right
    anchor_y: bottom # bottom
    y: bottom+3 # -3
    x: right-42 # -42
    font_size: 30
    z: 1
    color: red
    animations:
        show_slide:
            -   property: opacity
                value: 1
                duration: 0.4s
            -   property: opacity
                value: 0
                duration: 0.4s
                repeat: true
show_player:
    mode_attract_started: # test comment 1
        attract_dmd_loop:
            loops: -1
            speed: 1
        multiball_sweep:
            loops: -1 # test comment 3
            speed: 10
        random_flashing:
            loops: -1
            speed: 6
    mode_attract_stopped:
        attract_dmd_loop:
            action: stop

    mode_claw_lit_for_major_mode_started:
        flash:
            key: claw_lit
            speed: 5
            loops: -1
            show_tokens:
                lights: l_claw_ready, l_right_ramp_arrow
    balldevice_elevator_ball_enter:
        claw_lit:
            action: stop
    mode_model_acmag_started:
        flash:
            speed: 4
            loops: -1
            show_tokens:
                lights: l_left_ramp_arrow
    led_show1:
        flash:
            speed: 4
            loops: -1

```



```
show_tokens:
  leds: led1
```

Listing 22.132: `your_machine_folder/config/test_show1_v4.yaml`

```
# show_version=4
- time: 0
  slides:
    test_show1_v3_slide_1:
      - type: text
        text: MISSION PINBALL
        color: red
      - type: rectangle
        width: 128
        height: 32
- time: '+2'
  slides:
    test_show1_v3_slide_2:
      widgets:
        - type: image
          image: demo_man_logo
      transition:
        type: move_out
        duration: 1s
        direction: top
- time: '+2'
  slides:
    test_show1_v3_slide_3:
      - type: text
        text: (machine|credits_string)
- time: '+2'
  slides:
    test_show1_v3_slide_4:
      - type: text
        text: (machine|score1_label)
        anchor_y: top
        y: top-4
      - type: text
        text: (machine|score1_name) (machine|score1_value)
        anchor_y: bottom
        number_grouping: true
        y: bottom+3
      - type: rectangle
        width: 128
        height: 32
      - type: rectangle
        width: 126
        height: 30
        brightness: 8
- time: '+2'
  slides:
    test_show1_v3_slide_5:
      widgets:
        - type: text
          text: 1. (machine|score2_name) (machine|score2_value)
```



```

        anchor_y: top
        anchor_x: left
        number_grouping: true
        y: top-3
        x: left+12
    -   type: text
        text: 2. (machine|score3_name) (machine|score3_value)
        anchor_y: bottom
        anchor_x: left
        number_grouping: true
        y: bottom+3
        x: left+10
    transition:
        type: move_out
        duration: 1s
        direction: top
-   time: '+2'
    slides:
        test_show1_v3_slide_6:
            widgets:
    -       type: text
            text: 3. (machine|score4_name) (machine|score4_value)
            anchor_y: top
            y: top-3
            x: left+10
            number_grouping: true
            anchor_x: left
    -       type: text
            text: 4. (machine|score5_name) (machine|score5_value)
            anchor_y: bottom
            number_grouping: true
            y: bottom+3
            x: left+10
            anchor_x: left
        transition:
            type: move_in
            duration: 1s
            direction: bottom
-   time: '+2'
    slides:
        test_show1_v3_slide_7:
            widgets:
    -       type: text
            text: MASTER LOOPER
            anchor_y: top
            style: medium
            y: top
    -       type: text
            text: (machine|loops1_name)
            style: tall title
    -       type: text
            text: (machine|loops1_value) LOOPS
            anchor_y: bottom
            style: medium
            number_grouping: true

```



```

        y: bottom
        transition:
            type: move_in
            duration: 1s
            direction: bottom
-   time: '+2'
    slides:
        test_show1_v3_slide_8:
            -   type: text
                text: (machine|player1_score)
                number_grouping: true
                min_digits: 2
                style: small
                anchor_y: top
                anchor_x: right
                x: right-80
                y: top-1
            -   type: text
                text: (machine|player2_score)
                number_grouping: true
                min_digits: 2
                style: small
                anchor_y: top
                anchor_x: right
                x: right-1
                y: top-1
            -   type: text
                text: (machine|player3_score)
                number_grouping: true
                min_digits: 2
                style: small
                anchor_y: bottom
                anchor_x: right
                x: right-80
                y: bottom+10
            -   type: text
                text: (machine|player4_score)
                number_grouping: true
                min_digits: 2
                style: small
                anchor_y: bottom
                anchor_x: right
                x: right-1
                y: bottom+10
            -   type: text
                text: (machine|credits_string)
                style: small
                anchor_y: bottom
                y: bottom
-   time: '+1'
    lights:
        l_car_crash_bottom: ff
-   time: '+1'
    lights:
        l_car_crash_center: ff

```



```

-   time: '+1'
    lights:
      l_car_crash_top: ff
-   time: '+1'
    lights:
      l_car_crash_top: 0
      l_car_crash_center: 0
      l_car_crash_bottom: 0
-   time: '+1'
    leds:
      board_red: ff0000
      board_black: 0
-   time: '+1'
    leds:
      board_red: 0
      board_black: 0000ff
-   time: '+1'

```

Show file examples

Here are some example show files that go along with the above config(s).

Note that there are multiple shows here.

Listing 22.133: `your_machine_folder/shows/attract_dmd_loop.yaml`

```

# show_version=4
- time: 0

```

Listing 22.134: `your_machine_folder/shows/multiball_sweep.yaml`

```

# show_version=4
- time: 0
  lights:
    l_fortress_multiball: ff
- time: '+1'
  lights:
    l_museum_multiball: ff
- time: '+1'
  lights:
    l_wasteland_multiball: ff
- time: '+1'
  lights:
    l_cryoprison_multiball: ff
- time: '+1'
  lights:
    l_fortress_multiball: 0
- time: '+1'
  lights:
    l_museum_multiball: 0
- time: '+1'
  lights:
    l_wasteland_multiball: 0
- time: '+1'

```



```
lights:
  l_cryoprison_multiball: 0
- time: '+1'
```

Listing 22.135: `your_machine_folder/shows/random_flashing.yaml`

```
# show_version=4
- time: 0
lights:
  l_ball_save: ff
  l_super_jackpot: ff
  l_computer: ff
  l_demo_time: ff
  l_retina_scan: ff
- time: '+1'
lights:
  l_ball_save: 0
  l_super_jackpot: 0
  l_computer: 0
  l_demo_time: 0
  l_retina_scan: 0
- time: '+1'
```

mode_tests (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Note that there are multiple machine config examples here. They're just included to show different options. You wouldn't actually use more than one.

Listing 22.136: `your_machine_folder/config/test_broken_mode_config.yaml`

```
#config_version=4

modes:
  - mode2
  - broken_mode
```

Listing 22.137: `your_machine_folder/config/test_loading_invalid_modes.yaml`

```
#config_version=4

modes:
  - invalid
  - mode2
```


Listing 22.138: `your_machine_folder/config/test_missing_mode_section.yaml`

```
#config_version=4

modes:
  - broken_mode2
  - mode2
```

Listing 22.139: `your_machine_folder/config/test_modes.yaml`

```
#config_version=4

modes:
  - mode1
  - Mode2
  - mode3
  - mode4
```

Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Note that there are multiple mode config examples here. You might not necessarily use more than one in your machine.

Listing 22.140: `your_machine_folder/modes/broken_mode/config/broken_mode.yaml`

```
#config_version=4

mode:
  invalid_key: crap
```

Listing 22.141: `your_machine_folder/modes/broken_mode2/config/broken_mode2.yaml`

```
#config_version=4

unrelated_section:
  invalid_key: crap
```

Listing 22.142: `your_machine_folder/modes/mode1/config/mode1.yaml`

```
#config_version=4
mode:
  start_events: start_mode1
  stop_events: stop_mode1
  priority: 200
  start_priority: 1
  stop_on_ball_end: false
  game_mode: False

config:
  - test.yaml
```


Listing 22.143: `your_machine_folder/modes/mode1/config/test.yaml`

```
#config_version=4
mode_settings:
  test: 123
```

Listing 22.144: `your_machine_folder/modes/mode2/config/mode2.yaml`

```
#config_version=4

mode:
  stop_events: stop_mode2
  stop_priority: 2
  restart_on_next_ball: true
  game_mode: False
```

Listing 22.145: `your_machine_folder/modes/mode3/code/mode3.py`

```
from mpf.core.mode import Mode

class Mode3(Mode):
    def mode_init(self):
        self.custom_code = True

    def mode_start(self, **kwargs):
        pass

    def mode_stop(self, **kwargs):
        pass
```

Listing 22.146: `your_machine_folder/modes/mode3/config/mode3.yaml`

```
#config_version=4

mode:
  code: mode3.Mode3
```

Listing 22.147: `your_machine_folder/modes/mode4/config/mode4.yaml`

```
#config_version=4
mode:
  start_events: start_mode4
  use_wait_queue: True
  game_mode: False
```

modes (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.148: `your_machine_folder/config/test_modes.yaml`

```
#config_version=4
modes:
  - mode1
```

Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Listing 22.149: `your_machine_folder/modes/mode1/config/mode1.yaml`

```
#config_version=4
mode:
  priority: 300
```

motor (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.150: `your_machine_folder/config/config.yaml`

```
#config_version=4

switches:
  s_position_up:
    number:
  s_position_down:
    number:

coils:
  c_motor_run:
    number:
    allow_enable: True

motors:
  motorized_drop_target_bank:
    motor_coil: c_motor_run
    position_switches:
      up: s_position_up
      down: s_position_down
    reset_position: down
    go_to_position:
      go_up: up
      go_down: down
      go_down2: down
```


mpf_plugin_config_player_validation (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.151: `your_machine_folder/config/mpf_plugin_validation.yaml`

```
# config_version=4

show_player:
  event1: show1
```

Show file examples

Here are some example show files that go along with the above config(s).

Listing 22.152: `your_machine_folder/shows/show1.yaml`

```
# show_version=4
- time: 0
  slides:
    slide1: # device
      type: text # device_settings
      text: TEST 1
      color: ff0000
      font_size: 100
- time: 1
  slides:
    slide_7: # device
      - type: text # device_settings
        text: TEXT FROM SLIDE_PLAYER LIST
        color: red
        font_size: 15
        y: 66%
      - type: text
        text: WIDGET 2
        color: purple
        font_size: 15
        y: 33%
- time: 2
  slides:
    slide_8: # device
      widgets: # device_settings
      - type: text
        text: TEXT FROM SLIDE_PLAYER WIDGET LIST
        color: green
        font_size: 15
        y: 66%
      - type: text
        text: WIDGET 2
        color: lime
```



```

        font_size: 15
        y: 33%
        target: display1
        transition: move_in
- time: 3
  slides: slide2
- time: 4
  slides:
    slide_9:
      widgets: # device_settings
      - type: text
        text: TEXT FROM SLIDE_PLAYER WIDGET LIST
        color: green
        font_size: 15
        y: 66%
      - type: text
        text: WIDGET 2
        color: lime
        font_size: 15
        y: 33%
      target: display1
      transition: move_in
    slide_10:
      widgets: # device_settings
      - type: text
        text: TEXT FROM SLIDE_PLAYER WIDGET LIST
        color: green
        font_size: 15
        y: 66%
      - type: text
        text: WIDGET 2
        color: lime
        font_size: 15
        y: 33%
      target: dmd
      transition: move_in

```

mpfmc_configs (example config files)

mpftestcase (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.153: `your_machine_folder/config/test_mpftestcase.yaml`

```

#config_version=4

switches:

```



```
switch1:  
  number:
```

multiball (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.154: `your_machine_folder/config/config.yaml`

```
#config_version=4  
  
game:  
  balls_per_game: 1  
  
coils:  
  eject_coil1:  
    number:  
  eject_coil2:  
    number:  
  eject_coil3:  
    number:  
  
switches:  
  s_start:  
    number:  
    tags: start  
  s_ball_switch1:  
    number:  
  s_ball_switch2:  
    number:  
  s_ball_switch3:  
    number:  
  s_ball_switch4:  
    number:  
  s_ball_switch5:  
    number:  
  s_ball_switch6:  
    number:  
  s_lock1:  
    number:  
  s_lock2:  
    number:  
  s_ball_switch_launcher:  
    number:  
  
ball_devices:  
  bd_trough:  
    eject_coil: eject_coil1  
    ball_switches: s_ball_switch1, s_ball_switch2, s_ball_switch3, s_ball_switch4, s_ball_switch5,   
↪s_ball_switch6
```



```
    confirm_eject_type: target
    eject_targets: bd_launcher
    tags: trough, drain, home
bd_launcher:
    eject_coil: eject_coil2
    ball_switches: s_ball_switch_launcher
    confirm_eject_type: target
    eject_timeouts: 2s
    tags: ball_add_live
bd_lock:
    eject_coil: eject_coil3
    ball_switches: s_lock1, s_lock2
    eject_timeouts: 2s

modes:
- mode1
- mode2
- mode3
- mode4

multiballs:
  mb1:
    ball_count: 1
    ball_count_type: add
    shoot_again: 30s
    enable_events: mb1_enable
    disable_events: mb1_disable
    start_events: mb1_start
    stop_events: mb1_stop
  mb2:
    ball_count: 2
    ball_count_type: add
    shoot_again: -1
    enable_events: mb2_enable
    disable_events: mb2_disable
    start_events: mb2_start
    stop_events: mb2_stop
  mb3:
    ball_count: 1
    ball_count_type: add
    shoot_again: 0
    enable_events: mb3_enable
    disable_events: mb3_disable
    start_events: mb3_start
    stop_events: mb3_stop
  mb10:
    ball_count: 3
    ball_count_type: total
    shoot_again: 20s
    start_events: mb10_start
  mb_add_a_ball:
    ball_count: 2
    start_or_add_a_ball_events: start_or_add
    add_a_ball_events: add_ball
```


Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Note that there are multiple mode config examples here. You might not necessarily use more than one in your machine.

Listing 22.155: `your_machine_folder/modes/mode1/config/mode1.yaml`

```
#config_version=4
mode:
  start_events: start_mode1
  stop_events: stop_mode1

multiballs:
  mb4:
    ball_count: 1
    ball_count_type: add
    shoot_again: 30s
    enable_events: mb4_enable
    disable_events: mb4_disable
    start_events: mb4_start
    stop_events: mb4_stop

  mb11:
    ball_count: 2
    ball_count_type: total
    shoot_again: 20s
    start_events: mb11_start
    ball_locks: bd_lock

  mb12:
    ball_count: current_player.lock_mb6_locked_balls
    ball_count_type: add
    shoot_again: 20s
    start_events: mb12_start
    ball_locks: bd_lock

  mb6:
    ball_count: 2
    ball_count_type: add
    shoot_again: 0
    start_events: mb6_start
    ball_locks: bd_lock

multiball_locks:
  lock_mb6:
    lock_devices: bd_lock
    balls_to_lock: 2
    reset_count_for_current_player_events: mb6_start
    disable_events: mb6_start
```


Listing 22.156: `your_machine_folder/modes/mode2/config/mode2.yaml`

```
#config_version=4
mode:
  start_events: start_mode2
  stop_events: stop_mode2

multiballs:
  mb5:
    ball_count: 1
    ball_count_type: add
    start_events: mb5_start
```

Listing 22.157: `your_machine_folder/modes/mode3/config/mode3.yaml`

```
#config_version=4
mode:
  start_events: start_mode3
  stop_events: stop_mode3

multiballs:
  mb_autostart:
    ball_count: 2
    start_events: mode_mode3_started
```

Listing 22.158: `your_machine_folder/modes/mode4/config/mode4.yaml`

```
#config_version=4
mode:
  start_events: start_mode4
  stop_events: stop_mode4

multiballs:
  mb4_autostart:
    ball_count: 2
    ball_count_type: total
    shoot_again: 0s
    start_events: multiball_lock_lock_mb_autostart_full
    ball_locks: bd_lock

multiball_locks:
  lock_mb_autostart:
    lock_devices: bd_lock
    balls_to_lock: 1
```

null (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.159: `your_machine_folder/config/null.yaml`

```
#config_version=4
```

openpixel (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Note that there are multiple machine config examples here. They're just included to show different options. You wouldn't actually use more than one.

Listing 22.160: `your_machine_folder/config/config.yaml`

```
#config_version=4

leds:
  test_led:
    number: 99
  test_led2:
    number: 0-20
  test_led3:
    number: 1-99
```

Listing 22.161: `your_machine_folder/config/fadecandy.yaml`

```
#config_version=4

config:
- config.yaml
```

opp (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.162: `your_machine_folder/config/config.yaml`

```
#config_version=4

hardware:
  platform: opp
  driverboards: gen2

opp:
  ports: com1
```



```
    baud: 115200
    debug: True

switches:
    s_test:
        number: 0-0
    s_test_no_debounce:
        number: 0-1
        debounce: quick
    s_test_nc:
        number: 0-2
        type: 'NC'
    s_flipper:
        number: 0-3
    s_test_card2:
        number: 0-8

coils:
    c_test:
        number: 0-0
        pulse_ms: 23
    c_test_allow_enable:
        number: 0-1
        pulse_ms: 23
        recycle_factor: 3
        allow_enable: true
    c_flipper_hold:
        number: 0-2
        allow_enable: true
    c_flipper_main:
        number: 0-3
        pulse_ms: 10
        hold_power: 3
    c_holdpower_16:
        number: 1-12
        hold_power16: 1

matrix_lights:
    test_light1:
        number: 0-16
    test_light2:
        number: 0-17

leds:
    test_led1:
        number: 1-0
    test_led2:
        number: 1-1

autofire_coils:
    ac_slingshot_test:
        coil: c_test
        switch: s_test

    ac_slingshot_test2:
```



```

coil: c_test_allow_enable
switch: s_test_no_debounce

flippers:
  f_test_single:
    debug: true
    #main_coil_overwrite:
    #   pulse_ms: 11
    main_coil: c_flipper_main
    activation_switch: s_flipper

  f_test_hold:
    debug: true
    main_coil: c_flipper_main
    hold_coil: c_flipper_hold
    activation_switch: s_flipper

```

p3_roc (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.163: `your_machine_folder/config/config.yaml`

```

#config_version=4

hardware:
  driverboards: pdb
  platform: p3_roc
  servo_controllers: i2c_servo_controller

switches:
  s_test_000:
    number: A0-B0-0
  s_test_001:
    number: 0/0/3
  s_test:
    number: A1-B0-7
  s_test_no_debounce:
    number: A1-B1-0
    debounce: quick
  s_slingshot_test:
    number: A2-B1-0
  s_test_nc:
    number: A2-B1-1
    type: 'NC'
  s_flipper:
    number: 1
  s_flipper_eos:
    number: 2

```



```
coils:
  c_test:
    number: A1-B1-2
    pulse_ms: 23
  c_test_allow_enable:
    number: A1-B1-3
    pulse_ms: 23
    allow_enable: true
  c_slingshot_test:
    number: A0-B1-0
  c_coil_pwm_test:
    number: A0-B1-1
    pwm_on_ms: 2
    pwm_off_ms: 8
  c_flipper_main:
    number: A0-B0-1
    pulse_ms: 10
    hold_power: 3
  c_flipper_hold:
    number: A0-B0-2
    hold_power: 1

autofire_coils:
  ac_slingshot_test:
    coil: c_slingshot_test
    switch: s_slingshot_test
  ac_switch_nc_test:
    coil: c_coil_pwm_test
    switch: s_test_nc

servo_controller:
  address: 0x40

servos:
  serv01:
    number: 3

accelerometers:
  p3_roc_accelerometer:
    number: 1

flippers:
  f_test_single:
    debug: true
    main_coil_overwrite:
      pulse_ms: 11
    main_coil: c_flipper_main
    activation_switch: s_flipper

  f_test_hold:
    debug: true
    main_coil: c_flipper_main
    hold_coil: c_flipper_hold
    activation_switch: s_flipper
```



```

    f_test_hold_eos:
      debug: true
      main_coil: c_flipper_main
      hold_coil: c_flipper_hold
      activation_switch: s_flipper
      eos_switch: s_flipper_eos
      use_eos: true

matrix_lights:
  test_pdb_light:
    number: C-A2-B0-0:R-A2-B1-0

gis:
  test_gi:
    number: A2-B0-3

leds:
  test_led:
    number: 2-1-2-3
  test_led_inverted:
    number: 2-4-5-6
    polarity: True

```

p_roc (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Note that there are multiple machine config examples here. They're just included to show different options. You wouldn't actually use more than one.

Listing 22.164: [your_machine_folder/config/config.yaml](#)

```

#config_version=4

hardware:
  driverboards: pdb
  platform: p_roc

P_ROC:
  dmd_timing_cycles: 1, 2, 3, 4

switches:
  s_test_000:
    number: 0
  s_test_001:
    number: 2
  s_test:
    number: 23
  s_test_no_debounce:
    number: 24

```



```

    debounce: quick
    s_slingshot_test:
        number: 40
    s_direct:
        number: SD01
    s_matrix:
        number: 2/3

coils:
    c_test:
        number: A1-B1-2
        pulse_ms: 23

    c_test_allow_enable:
        number: A1-B1-3
        pulse_ms: 23
        allow_enable: true
    c_slingshot_test:
        number: A0-B1-0
    c_test2: # unused. just to configure bank 0
        number: A0-B0-0
    c_direct:
        number: C01
    c_pwm_on_off:
        number: A1-B1-4
        pwm_on_ms: 2
        pwm_off_ms: 5

autofire_coils:
    ac_slingshot_test:
        coil: c_slingshot_test
        switch: s_slingshot_test

matrix_lights:
    test_pdb_light:
        number: C-A2-B0-0:R-A2-B1-0
    test_direct_light:
        number: L01

gis:
    test_gi:
        number: A2-B0-3

```

Listing 22.165: `your_machine_folder/config/snux.yaml`

```

#config_version=4

hardware:
    coils: snux
    driverboards: wpc
    platform: p_roc

system11:
    ac_relay_delay_ms: 75

```



```
    ac_relay_driver: c_ac_relay

snux:
  flipper_enable_driver: c_flipper_enable_driver
  diag_led_driver: c_diag_led_driver
  platform:

switches:
  s_test_fliptronics:
    number: sf1
  s_test_direct:
    number: sd1
  s_test_matrix:
    number: s26

coils:
  c_test_direct:
    number: c01
  c_test_a_side:
    number: c02a
  c_test_c_side:
    number: c02c
    allow_enable: true
  c_flipper_enable_driver:
    number: c23
    allow_enable: true
  c_diag_led_driver:
    number: c24
    allow_enable: true
  c_ac_relay:
    number: c25
    allow_enable: true
```

Listing 22.166: `your_machine_folder/config/wpc.yaml`

```
#config_version=4

hardware:
  driverboards: wpc
  platform: p_roc

switches:
  s_test_fliptronics:
    number: sf1
  s_test_direct:
    number: sd1
  s_test_matrix:
    number: s26

coils:
  c_test_direct:
    number: c01
    pulse_ms: 23
  c_test_fliptronics:
    number: fl1m
```



```
pulse_ms: 23

matrix_lights:
  test_light:
    number: l11

gis:
  test_gi_direct:
    number: g01
```

physical_dmd (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Note that there are multiple machine config examples here. They're just included to show different options. You wouldn't actually use more than one.

Listing 22.167: `your_machine_folder/config/testPhysicalDmd.yaml`

```
#config_version=4

physical_dmds:
  test_dmd:
    label: Test
```

Listing 22.168: `your_machine_folder/config/testPhysicalRgbDmd.yaml`

```
#config_version=4

physical_rgb_dmds:
  test_dmd:
    label: Test
```

platform (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Note that there are multiple machine config examples here. They're just included to show different options. You wouldn't actually use more than one.

Listing 22.169: `your_machine_folder/config/test_platform.yaml`

```
#config_version=4
```



```
hardware:
  leds: smart_virtual, fadecandy

leds:
  led1:
    number: 1
  led2:
    number: 2
    platform: fadecandy
```

Listing 22.170: `your_machine_folder/config/test_virtual.yaml`

```
#config_version=4

switches:
  s_test:
    number: 1
    debounce_open: 20ms

coils:
  c_test:
    pulse_power32: 123
    pwm_on_ms: 5
    pwm_off_ms: 1
    number: 1
  c_test_no_allow_enable:
    number: 2
  c_test_allow_enable:
    number: 3
    allow_enable: True
  c_test_hold_fast:
    number: 4
    hold_power32: 123
  c_test_hold_p_roc:
    number: 5
    pwm_on_ms: 1
    pwm_off_ms: 2
  c_test_hold_power:
    number: 6
    hold_power: 3

autofire_coils:
  ac_test:
    coil: c_test
    switch: s_test
    coil_overwrite:
      pwm_off_ms: 20
      pulse_pwm_mask: 123
    switch_overwrite:
      debounce: quick
```


player_vars (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.171: [your_machine_folder/config/player_vars.yaml](#)

```
#config_version=4

player_vars:
  some_var:
    initial_value: 4
  some_float:
    initial_value: 4
    value_type: float
  some_string:
    initial_value: 4
    value_type: str
  some_other_string:
    initial_value: hello
    value_type: str # required for non-ints

machine_vars:
  test1:
    initial_value: 4
    value_type: int
  test2:
    initial_value: '5'
    value_type: str

# below is the min config we need to be able to start a game

game:
  balls_per_game: 3

coils:
  eject_coil1:
    number:
  eject_coil2:
    number:

switches:
  s_start:
    number:
    tags: start
  s_ball_switch1:
    number:
  s_ball_switch2:
    number:
  s_ball_switch_launcher:
    number:

ball_devices:
```



```
bd_trough:
  eject_coil: eject_coil1
  ball_switches: s_ball_switch1, s_ball_switch2
  debug: true
  confirm_eject_type: target
  eject_targets: bd_launcher
  tags: trough, drain, home
bd_launcher:
  eject_coil: eject_coil2
  ball_switches: s_ball_switch_launcher
  debug: true
  confirm_eject_type: target
  eject_timeouts: 2s
  tags: ball_add_live
```

playfield (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.172: `your_machine_folder/config/test_playfield.yaml`

```
#config_version=4

switches:
  s_playfield:
    number:
    tags: playfield_active
```

playfield_transfer (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.173: `your_machine_folder/config/config.yaml`

```
#config_version=4

switches:
  s_transfer:
    number:

playfield_transfers:
  transfer1:
    ball_switch: s_transfer
    captures_from: playfield1
```



```

    eject_target: playfield2

  transfer2:
    transfer_events: transfer_ball
    captures_from: playfield1
    eject_target: playfield2

playfields:
  playfield1:
    label: Playfield 1
  playfield2:
    label: Playfield 2

```

plugin_config_player (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.174: `your_machine_folder/config/plugin_config_player.yaml`

```

#config_version=4

modes:
  - mode1

test_player:
  event1: some_string
  event2:
    some: dict
    with: arbitrary
    values: '.'
  event5{foo==0}: some_string

test2_player:
  event2: slide1
  event3: slide2

```

Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Note that there are multiple mode config examples here. You might not necessarily use more than one in your machine.

Listing 22.175: `your_machine_folder/modes/mode1/config/mode1.yaml`

```

# config_version=4

mode:
  priority: 400

```



```

game_mode: False

test_player:
  event1: some_string
  event4: something

test2_player:
  event2: slide1
  event3: slide2

show_player:
  start_show2: show2
  start_show3: show3

```

Listing 22.176: `your_machine_folder/modes/mode1/shows/show2.yaml`

```

# show_version=4
- time: 0
  tests:
    some:
      key1: thing

- time: 1
  tests:
    some:
      key: value
      key1: value
  test2s:
    some:
      key1: value

```

Listing 22.177: `your_machine_folder/modes/mode1/shows/show3.yaml`

```

# show_version=4
- time: 0
  test3s:
    test3_something:
      test3_key: test3_value

```

Show file examples

Here are some example show files that go along with the above config(s).

Listing 22.178: `your_machine_folder/shows/show1.yaml`

```

# show_version=4
- time: 0
  tests:
    some5:
      key5: thing

- time: 1
  tests:
    slide1:

```



```
key6: value
key6.1: value
transition:
key7: value2
key7.1: value3
test2s:
some7:
key7: value
```

pololu_maestro (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.179: `your_machine_folder/config/pololu_maestro.yaml`

```
#config_version=4

hardware:
platform: virtual
driverboards: virtual
servo_controllers: pololu_maestro

pololu_maestro:
port: COM5
servo_min: 3000
servo_max: 9000

servos:
servo1:
servo_min: 0.0
servo_max: 1.0
reset_position: 0.5
reset_events: reset_servo1
number: 1
servo2:
servo_min: 0.2
servo_max: 0.8
reset_position: 1.0
reset_events: reset_servo2
number: 2
```

randomizer (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.180: [your_machine_folder/config/randomizer.yaml](#)

```
#config_version=4
```

score_reels (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.181: [your_machine_folder/config/config.yaml](#)

```
#config_version=4

machine:
  min_balls: 0

switches:
  s_start:
    number: 1
    tags: start
  score_1p_10k_0:
    number: 2
  score_1p_10k_9:
    number: 3
  score_1p_1k_0:
    number: 4
  score_1p_1k_9:
    number: 5
  score_1p_100_0:
    number: 6
  score_1p_100_9:
    number: 7
  score_1p_10_0:
    number: 8
  score_1p_10_9:
    number: 9
  score_2p_10_0:
    number: 10
  score_2p_10_9:
    number: 11

virtual_platform_start_active_switches:
  - score_1p_10k_0
  - score_1p_1k_0
  - score_1p_100_0
  - score_1p_10_0
  - score_2p_10_0

coils:
  player1_10k:
    number:
```



```
player1_1k:
  number:
player1_100:
  number:
player1_10:
  number:
player2_10:
  number:
chime1:
  number:
chime2:
  number:
chime3:
  number:

score_reels:
  score_1p_10k:
    coil_inc: player1_10k
    switch_0: score_1p_10k_0
    switch_9: score_1p_10k_9
    rollover: True
    limit_hi: 9
    limit_lo: 0
    repeat_pulse_time: 200ms
    hw_confirm_time: 300ms
  score_1p_1k:
    coil_inc: player1_1k
    switch_0: score_1p_1k_0
    switch_9: score_1p_1k_9
    rollover: True
    limit_hi: 9
    limit_lo: 0
    repeat_pulse_time: 200ms
    hw_confirm_time: 300ms
  score_1p_100:
    coil_inc: player1_100
    switch_0: score_1p_100_0
    switch_9: score_1p_100_9
    rollover: True
    limit_hi: 9
    limit_lo: 0
    repeat_pulse_time: 200ms
    hw_confirm_time: 300ms
  score_1p_10:
    coil_inc: player1_10
    switch_0: score_1p_10_0
    switch_9: score_1p_10_9
    rollover: True
    limit_hi: 9
    limit_lo: 0
    repeat_pulse_time: 200ms
    hw_confirm_time: 300ms
  score_2p_10:
    coil_inc: player2_10
    switch_0: score_2p_10_0
```



```
    switch_9: score_2p_10_9
    rollover: True
    limit_hi: 9
    limit_lo: 0
    repeat_pulse_time: 200ms
    hw_confirm_time: 300ms

score_reel_groups:
  player1:
    reels: score_1p_10k, score_1p_1k, score_1p_100, score_1p_10, None
    tags: player1
    max_simultaneous_coils: 2
    chimes: None, chime1, chime2, chime3, None
    confirm: lazy
    lights_tag: player1
  player2:
    reels: score_2p_10, None
    tags: player2
    max_simultaneous_coils: 2
    chimes: chime3, None
    confirm: lazy
    lights_tag: player2

matrix_lights:
  light_p1:
    number:
    tags: player1
  light_p2:
    number:
    tags: player2
```

scoring (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.182: [your_machine_folder/config/config.yaml](#)

```
#config_version=4

# minimal config to start game
game:
  balls_per_game: 2

coils:
  eject_coil1:
    number:

switches:
  s_start:
    number:
```



```

    tags: start
  s_ball_switch1:
    number:
  s_ball_switch2:
    number:

ball_devices:
  test_trough:
    ball_switches: s_ball_switch1, s_ball_switch2
    eject_coil: eject_coil1
    tags: trough, drain, home, ball_add_live

modes:
- mode1
- mode2
- mode3

```

Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Note that there are multiple mode config examples here. You might not necessarily use more than one in your machine.

Listing 22.183: `your_machine_folder/modes/mode1/config/mode1.yaml`

```

#config_version=4
mode:
  start_events: start_mode1
  stop_events: stop_mode1
  priority: 200

scoring:
  test_event1:
    score: 100
    var_a: 1
    var_c: current_player.ramps
  test_set_100:
    test1:
      score: 100
      action: set
  test_set_200:
    test1:
      score: 200
      action: set
  test_set_string:
    string_test:
      string: HELLO
  test_set_machine_var:
    my_var:
      score: 100
      action: set_machine
  test_add_machine_var:
    my_var:

```



```
    score: 23
    action: add_machine
  player_score:
    my_var2:
      score: change
      action: add_machine
```

Listing 22.184: `your_machine_folder/modes/mode2/config/mode2.yaml`

```
#config_version=4
mode:
  start_events: start_mode2
  stop_events: stop_mode2
  priority: 300
  restart_on_next_ball: True

scoring:
  test_event1:
    score: 1000|block
    var_a: 0|block
    var_b: 1
    var_c: current_player.ramps * 10|block
```

Listing 22.185: `your_machine_folder/modes/mode3/config/mode3.yaml`

```
#config_version=4
mode:
  start_events: start_mode3
  stop_events: stop_mode3
  priority: 400

scoring:
  score_player1:
    score:
      score: 42
      player: 1
  score_player2:
    score:
      score: 23
      player: 2
  reset_player2:
    score:
      score: 10
      player: 2
      action: set
```

scriptlets (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.186: `your_machine_folder/config/config.yaml`

```
#config_version=4

scriptlets: test_scriptlet.TestScriptlet
```

service_mode (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.187: `your_machine_folder/config/config.yaml`

```
#config_version=4

modes:
  - attract
  - game
  - service
  - credits

credits:
  free_play: no
  service_credits_switch: s_service_esc

coils:
  c_test:
    number: 1
    label: First coil
  c_test2:
    number: 2
    label: Second coil

switches:
  s_door_open:
    number:
    tags: service_door_open, power_off
  s_service_enter:
    number:
    tags: service_enter
  s_service_esc:
    number:
    tags: service_esc
  s_service_up:
    number:
    tags: service_up
  s_service_down:
    number:
    tags: service_down
```


servo (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.188: `your_machine_folder/config/config.yaml`

```
#config_version=4

servos:
  limited_servo:
    number: 1
    servo_min: 0.2
    servo_max: 0.8
  test_servo:
    number: 2
    reset_position: 0.5
    reset_events: test_reset
    positions:
      0.0: test_00
      0.1: test_01
      1.0: test_10
```

shapes (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.189: `your_machine_folder/config/test_shapes.yaml`

```
#config_version=4

displays:
  default:
    width: 400
    height: 300

slides:
  slide1:
    - type: points
      points: 50, 50, 75, 50, 100, 30, 200, 50, 68, 250
      pointsize: 3
    - type: line
      points: 0, 0, 100, 100, 100, 200
      color: 00ff00
      thickness: 10
      close: true
    - type: bezier
```



```

    points: 400, 300, 100, 100, 400, 0
    color: pink
    thickness: 5
  - type: triangle
    points: 400, 300, 200, 300, 400, 200
    color: red
  - type: quad
    points: 50, 50, 55, 70, 100, 75, 110, 45
    color: lightblue
  - type: ellipse
    width: 100
    height: 100
    color: purple
    angle_start: 0
    angle_end: 45
  - type: rectangle
    x: 250
    y: 125
    width: 200
    height: 100
    color: orange
    corner_radius: 30
  - type: rectangle
    x: 350
    y: 50
    width: 50
    height: 100
    color: blue

slide_player:
  slide1: slide1

```

shots (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Note that there are multiple machine config examples here. They're just included to show different options. You wouldn't actually use more than one.

Listing 22.190: `your_machine_folder/config/test_shot_groups.yaml`

```

#config_version=4

modes:
  - mode_shot_groups
  - base

switches:
  switch_1:
    number:

```



```
switch_2:
  number:
switch_3:
  number:
switch_4:
  number:
s_rotate_l:
  number:
s_rotate_r:
  number:
switch_10:
  number:
switch_11:
  number:
switch_30:
  number:
switch_31:
  number:
switch_32:
  number:
switch_33:
  number:
switch_34:
  number:
switch_35:
  number:
switch_36:
  number:
switch_37:
  number:
switch_38:
  number:
switch_39:
  number:
switch_40:
  number:
switch_41:
  number:
switch_42:
  number:
switch_43:
  number:
switch_44:
  number:
switch_45:
  number:
switch_46:
  number:
s_GAS_G:
  number:
s_GAS_A:
  number:
s_GAS_S:
  number:
s_special_left:
```



```
    number:
s_special_right:
    number:

leds:
  led_10:
    number:
  led_11:
    number:
  led_30:
    number:
  led_31:
    number:
  led_32:
    number:
  led_33:
    number:
  led_34:
    number:
  led_35:
    number:
  led_36:
    number:
  led_37:
    number:
  led_38:
    number:
  led_39:
    number:
  led_40:
    number:
  led_41:
    number:
  led_42:
    number:
  l_GAS_G:
    number:
  l_GAS_A:
    number:
  l_GAS_S:
    number:

matrix_lights:
  l_special_right:
    number:
  l_special_left:
    number:

shots:
  shot_1:
    switch: switch_1
  shot_2:
    switch: switch_2
  shot_3:
    switch: switch_3
```



```
shot_4:
  switch: switch_4
shot_10:
  switch: switch_10
  show_tokens:
    leds: led_10
shot_11:
  switch: switch_11
  show_tokens:
    leds: led_11
shot_30:
  switch: switch_30
  show_tokens:
    leds: led_30
  profile: rainbow
shot_31:
  switch: switch_31
  show_tokens:
    leds: led_31
  profile: rainbow
shot_32:
  switch: switch_32
  show_tokens:
    leds: led_32
  enable_events: None
shot_33:
  switch: switch_33
  show_tokens:
    leds: led_33
  enable_events: None
shot_34:
  switch: switch_34
  show_tokens:
    leds: led_34
  enable_events: None
shot_35:
  switch: switch_35
  show_tokens:
    leds: led_35
  enable_events: None
shot_36:
  switch: switch_36
  show_tokens:
    leds: led_36
  enable_events: None
shot_37:
  switch: switch_37
  show_tokens:
    leds: led_37
  enable_events: None
shot_38:
  switch: switch_38
  show_tokens:
    leds: led_38
  enable_events: None
```



```
shot_39:
  switch: switch_39
  show_tokens:
    leds: led_39
  enable_events: None
shot_40:
  switch: switch_40
  show_tokens:
    leds: led_40
  enable_events: None
shot_41:
  switch: switch_41
  show_tokens:
    leds: led_41
  enable_events: None
shot_42:
  switch: switch_42
  show_tokens:
    leds: led_42
  enable_events: None
shot_43:
  switch: switch_43
shot_44:
  switch: switch_44
shot_45:
  switch: switch_45
  profile: rainbow
shot_46:
  switch: switch_46
  profile: rainbow
shot_GAS_G:
  switch: s_GAS_G
  show_tokens:
    led: l_GAS_G
shot_GAS_A:
  switch: s_GAS_A
  show_tokens:
    led: l_GAS_A
shot_GAS_S:
  switch: s_GAS_S
  show_tokens:
    led: l_GAS_S
lane_special_left:
  switch: s_special_left
  show_tokens:
    light: l_special_left
lane_special_right:
  switch: s_special_right
  show_tokens:
    light: l_special_right

shot_groups:
  test_group:
    shots: shot_1, shot_2, shot_3, shot_4
```



```

    rotate_left_events: s_rotate_l_active
    rotate_right_events: s_rotate_r_active
    reset_events: shot_group_reset
    debug: True
test_group_2:
    shots: shot_10, shot_11
    rotate_left_events: rotate_11_left
    profile: rainbow
shot_group_30:
    shots: shot_30, shot_31
shot_group_32:
    shots: shot_32, shot_33
    enable_events: group32_enable
    disable_events: group32_disable
    reset_events: group32_reset
    rotate_left_events: group32_rotate_left
    rotate_right_events: group32_rotate_right
    rotate_events: group32_rotate
    enable_rotation_events: group32_enable_rotation
    disable_rotation_events: group32_disable_rotation
    advance_events: group32_advance
    remove_active_profile_events: group32_remove_active_profile
    profile: rainbow_no_hold
shot_group_34:
    shots: shot_34, shot_35, shot_36
    profile: shot_profile_34
shot_group_37:
    shots: shot_37, shot_38, shot_39
    profile: shot_profile_37
shot_group_40:
    shots: shot_40, shot_41, shot_42
    profile: shot_profile_40
shot_group_43:
    shots: shot_43, shot_44
shot_group_45:
    profile: rainbow_no_hold
    shots: shot_45, shot_46
group_GAS:
    shots: shot_GAS_G, shot_GAS_A, shot_GAS_S
    reset_events:
        group_GAS_default_lit_complete: 2s
special:
    shots: lane_special_left
    profile: prof_toggle
shows:
    rainbow:
        - leds:
            (leds): off
        - leds:
            (leds): red
        - leds:
            (leds): orange
        - leds:
            (leds): yellow

```



```
- leds:
  (leds): green
leds_off:
- leds:
  (led): off
leds_on:
- leds:
  (led): white

shot_profiles:
rainbow:
  show: rainbow
  states:
    - name: unlit
    - name: red
    - name: orange
    - name: yellow
    - name: green
rainbow_no_hold:
  show: rainbow
  states:
    - name: unlit
    - name: red
    - name: orange
    - name: yellow
    - name: green
shot_profile_34:
  show: rainbow
  state_names_to_rotate: red, green
  states:
    - name: unlit
    - name: red
    - name: orange
    - name: yellow
    - name: green
shot_profile_37:
  show: rainbow
  state_names_to_not_rotate: unlit
  states:
    - name: unlit
    - name: red
    - name: orange
    - name: yellow
    - name: green
shot_profile_40:
  show: rainbow
  rotation_pattern: r, r, l, l
  states:
    - name: unlit
    - name: red
    - name: orange
    - name: yellow
    - name: green
prof_toggle:
  states:
```



```
- name: unlit_toggle
  show: off
- name: lit_toggle
  show: on
loop: true
```

Listing 22.191: `your_machine_folder/config/test_shots.yaml`

```
#config_version=4
```

```
modes:
```

- mode1
- mode2

```
switches:
```

```
  switch_1:
    number:
  switch_2:
    number:
  switch_3:
    number:
  switch_4:
    number:
  switch_5:
    number:
  switch_6:
    number:
  switch_7:
    number:
  switch_8:
    number:
  switch_9:
    number:
  switch_10:
    number:
  s_delay:
    number:
  switch_11:
    number:
  switch_12:
    number:
  switch_13:
    number:
  switch_14:
    number:
  switch_15:
    number:
  switch_16:
    number:
  switch_17:
    number:
  switch_18:
    number:
  switch_19:
    number:
```



```
switch_20:
  number:
switch_21:
  number:
switch_22:
  number:
switch_26:
  number:
switch_27:
  number:
switch_28:
  number:

matrix_lights:
  light_1:
    number:
    tags: tag1
  light_2:
    number:
    tags: tag2
  light_3:
    number:

leds:
  led_1:
    number:
  led_2:
    number:
  led_3:
    number:
  led_4:
    number:
  led_11:
    number:
  led_12:
    number:
  led_13:
    number:
  led_14:
    number:
  led_15:
    number:
  led_16:
    number:
  led_17:
    number:
  led_18:
    number:
  led_19:
    number:
  led_20:
    number:
  led_21:
    number:
  led_23:
```



```
    number:
led_24:
    number:
led_25:
    number:
led_26:
    number:
led_27:
    number:
led_28:
    number:

shots:
shot_1:
    switch: switch_1
    show_tokens:
        light: light_1
shot_2:
    switch: switch_2
    show_tokens:
        light: light_2
    profile: three_states_loop
shot_3:
    switch: switch_3
    show_tokens:
        light: tag1
shot_4:
    switch: switch_1
    show_tokens:
        light: light_1, light_2
        led: led_1
led_1:
    switch: switch_1
    show_tokens:
        led: led_1
shot_sequence:
    switch_sequence: switch_1, switch_2, switch_3
    delay_switch:
        s_delay: 2s
    time: 2s
    cancel_switch: switch_4
default_show_light:
    switch: switch_5
    show_tokens:
        light: light_1
default_show_lights:
    switch: switch_6
    show_tokens:
        lights: light_1, light_2
default_show_led:
    switch: switch_7
    show_tokens:
        led: led_1
default_show_leds:
    switch: switch_8
```



```
    show_tokens:
      leds: led_1, led_2
show_in_profile_root:
  switch: switch_9
  show_tokens:
    leds: led_3
  profile: rainbow
shot_11:
  switch: switch_11
  show_tokens:
    leds: led_11
  profile: profile_11
shot_12:
  switch: switch_12
  show_tokens:
    leds: led_12
  profile: profile_12
shot_13:
  switch: switch_13
  show_tokens:
    leds: led_13
  profile: profile_13
shot_14:
  switch: switch_14
  show_tokens:
    leds: led_14
  profile: profile_14
shot_15:
  switches: switch_13, switch_14
shot_16:
  switch: switch_16
  enable_events: custom_enable_16
  disable_events: custom_disable_16
  reset_events: custom_reset_16
  hit_events: custom_hit_16
  advance_events: custom_advance_16
shot_17:
  switch: switch_17
  profile: profile_17
shot_18:
  switch: switch_18
  profile: profile_18
shot_19:
  switch: switch_19
  profile: profile_19
  enable_events: None
  show_tokens:
    leds: led_19
shot_20:
  switch: switch_20
  profile: profile_20
  enable_events: None
  show_tokens:
    leds: led_20
shot_21:
```



```
    switch: switch_21
    profile: profile_21
shot_22:
    switch: switch_22
    profile: profile_22
shot_23:
    show_tokens:
        leds: led_23
    profile: profile_23
shot_24:
    show_tokens:
        leds: led_24
    profile: profile_24
shot_25:
    show_tokens:
        leds: led_25
    profile: profile_25
shot_26:
    switch: switch_26
    show_tokens:
        leds: led_26
    profile: profile_26
shot_27: # only one switch in sequence
    switch_sequence: switch_1
shot_28:
    sequence: event1, event2

shot_profiles:
    three_states_loop:
        loop: True
        states:
            - name: one
            - name: two
            - name: three
    rainbow:
        show: rainbow
        states:
            - name: red
            - name: orange
            - name: yellow
            - name: green
            - name: blue
            - name: purple
    profile_11:
        loop: true
        states:
            - name: step1
              show: rainbow
            - name: step2
              show: rainbow2
    profile_12:
        show: rainbow
        states:
            - name: one
            - name: two
```



```
- name: three
  show: rainbow2
  loops: -1
- name: four
- name: five
profile_13:
  states:
    - name: one
      show: rainbow
    - name: two
    - name: three
      show: rainbow2
profile_14:
  states:
    - name: one
      show: rainbow_stay_on
      loops: 0
    - name: two
profile_17:
  advance_on_hit: false
  states:
    - name: one
    - name: two
    - name: three
    - name: four
    - name: five
profile_18:
  player_variable: hello
  states:
    - name: one
    - name: two
    - name: three
    - name: four
    - name: five
profile_19:
  show_when_disabled: true
  states:
    - name: one
      show: rainbow
    - name: two
      show: rainbow2
profile_20:
  show_when_disabled: false
  states:
    - name: one
      show: rainbow
    - name: two
      show: rainbow2
profile_21:
  states:
    - name: base_one
    - name: base_two
    - name: base_three
profile_22:
  states:
```



```
- name: base_one
- name: base_two
- name: base_three
profile_23:
  states:
    - name: base_one
      show: rainbow
    - name: base_two
      show: rainbow
    - name: base_three
      show: rainbow
profile_24:
  states:
    - name: base_one
      show: rainbow_stay_on
      loops: 0
    - name: base_two
      show: rainbow_stay_on
profile_25:
  states:
    - name: base_one
      show: rainbow
      loops: 0
    - name: base_two
      show: rainbow
profile_26:
  states:
    - name: base_one
      show: rainbow
    - name: base_two
      show: rainbow
    - name: base_three
      show: rainbow
shows:
  rainbow:
    - leds:
        (leds): red
    - leds:
        (leds): orange
    - leds:
        (leds): yellow
    - leds:
        (leds): green
    - leds:
        (leds): blue
    - leds:
        (leds): purple
  rainbow_stay_on:
    - leds:
        (leds): red
    - leds:
        (leds): orange
    - leds:
        (leds): yellow
```



```

- leds:
  (leds): green
- leds:
  (leds): blue
- leds:
  (leds): purple
  duration: -1
rainbow2:
- leds:
  (leds): aliceblue
- leds:
  (leds): antiquewhite
- leds:
  (leds): aquamarine
- leds:
  (leds): azure
rainbow3:
- leds:
  (leds): beige
- leds:
  (leds): blueviolet
- leds:
  (leds): brown
- leds:
  (leds): burlywood

```

Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Note that there are multiple mode config examples here. You might not necessarily use more than one in your machine.

Listing 22.192: `your_machine_folder/modes/base/config/base.yaml`

```

#config_version=4
mode:
  # Note: its not a good idea to use game_started and game_ended for your base mode. We suggest you_
  ↪ use
  #      ball_starting as start_event and set stop_on_ball_end to true (default).
  start_events: game_started
  stop_events: game_ending
  priority: 100
  stop_on_ball_end: false

shot_groups:
  special2:
    shots: lane_special_right
    profile: prof_toggle2

shot_profiles:
  prof_toggle2:
    states:
      - name: unlit2

```



```
    show: off
  - name: lit2
    show: on
loop: true
```

Listing 22.193: `your_machine_folder/modes/model1/config/model1.yaml`

```
#config_version=4

mode:
  priority: 100
  game_mode: False

shots:
  model_shot_1:
    switch: switch_3
    show_tokens:
      light: light_3
  model_shot_17:
    switch: switch_17
    enable_events: custom_enable_17
    disable_events: custom_disable_17
    reset_events: custom_reset_17
    hit_events: custom_hit_17
  shot_21:
    profile: model_shot_21
  shot_22:
    profile: model_shot_22
  shot_23:
    profile: model_shot_23
  shot_26:
    profile: model_shot_26

shot_groups:
  mode_group:
    shots: model_shot_17,model_shot_1

shot_profiles:
  model_shot_21:
    block: true
    states:
      - name: model_one
      - name: model_two
      - name: model_three
  model_shot_22:
    block: false
    states:
      - name: model_one
      - name: model_two
      - name: model_three
  model_shot_23:
    states:
      - name: model_one
        show: rainbow2
      - name: model_two
```



```

    show: rainbow2
  - name: mode1_three
    show: rainbow2
mode1_shot_26:
  block: false
  states:
  - name: mode1_one
    show: rainbow2
  - name: mode1_two
    show: rainbow2
  - name: mode1_three
    show: rainbow2

```

Listing 22.194: `your_machine_folder/modes/mode2/config/mode2.yaml`

```

#config_version=4

mode:
  priority: 200

shots:
  shot_21:
    profile: mode2_shot_21
  shot_22:
    profile: mode2_shot_22
  shot_26:
    profile: mode2_shot_26
  mode2_shot_rainbow:
    switch: switch_27
    show_tokens:
      leds: led_27
    profile: rainbow
  mode2_shot_rainbow_start_step:
    switch: switch_28
    show_tokens:
      leds: led_28
    profile: rainbow_start_step
shot_profiles:
  mode2_shot_21:
    block: false
    states:
      - name: mode2_one
      - name: mode2_two
      - name: mode2_three
  mode2_shot_22:
    block: false
    states:
      - name: mode2_one
      - name: mode2_two
      - name: mode2_three
  rainbow_start_step:
    states:
      - name: red
        show: rainbow
        start_step: 1

```



```

    manual_advance: True
  - name: orange
    show: rainbow
    start_step: 2
    manual_advance: True
  - name: yellow
    show: rainbow
    start_step: 3
    manual_advance: True
  - name: green
    show: rainbow
    start_step: 4
    manual_advance: True
  - name: blue
    show: rainbow
    start_step: 5
    manual_advance: True
  - name: purple
    show: rainbow
    start_step: 6
    manual_advance: True
mode2_shot_26:
  block: false
  states:
  - name: mode2_one
    show: rainbow3
  - name: mode2_two
    show: rainbow3
  - name: mode2_three
    show: rainbow3

```

Listing 22.195: `your_machine_folder/modes/mode_shot_groups/config/mode_shot_groups.yaml`

```

#config_version=4

mode:
  priority: 100

shot_groups:
  test_group_in_mode:
    shots: shot_1, shot_2, shot_3
    profile: three_states_loop
    rotate_left_events: s_rotate_l_active
    rotate_right_events: s_rotate_r_active
    reset_events: shot_group_in_mode_reset
  shot_group_43:
    profile: profile_43
  group_GAS:
    profile: gas_lane_profile
    rotate_left_events: s_upper_left_flipper_active
    rotate_right_events: s_upper_right_flipper_active
    enable_events: mode_mode_shot_groups_started
    disable_events: ball_ending

shot_profiles:

```



```
three_states_loop:
  loop: True
  states:
    - name: one
    - name: two
    - name: three
profile_43:
  block: True
  states:
    - name: one
    - name: two
    - name: three
gas_lane_profile:
  advance_on_hit: true
  states:
    - name: unlit
      show: leds_off
    - name: lit
      show: leds_on
```

shows (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.196: `your_machine_folder/config/test_shows.yaml`

```
#config_version=4

modes:
  - mode1
  - mode2
  - mode3

leds:
  led_01:
    number: 0
    tags: tag1, row0
  led_02:
    number: 1
    tags: tag1, row0
  led_03:
    number: 2
  led_04:
    number: 3

matrix_lights:
  light_01:
    number: 0
    label: Test 0
    tags: tag1
```



```
    debug: True
light_02:
  number: 1
  label: Test 1
  tags: tag1
  debug: True
light_03:
  number: 2
  label: Test 1
  fade_ms: 1s
  debug: True

gis:
  gi_01:
    number: 0

coils:
  coil_01:
    number: 1
    pulse_ms: 30

flashers:
  flasher_01:
    number: 1
    label: Test flasher
    flash_ms: 40

shows:
  leds_name_token:
    - time: 0
      leds:
        (leds): red
  leds_color_token:
    - time: 0
      leds:
        led_01: (color1)
    - time: +1
      leds:
        led_02: (color2)
    - time: +1
  leds_extended:
    - time: 0
      leds:
        (leds):
          color: red
          fade: 1s
  lights_basic:
    - time: 0
      lights:
        (lights): ff
  multiple_tokens:
    - time: 0
      leds:
        (leds): blue
      lights:
```



```
(lights): ff
show_assoc_tokens:
- time: 0
  leds:
    (line1Num): (line1Color)
show_with_time_and_duration:
- time: +1s
- time: 5s
- time: +1s
  duration: 1s
- leds:
  led_02: red
- time: 10s
  duration: 3s
leds_color_token_and_fade:
- time: 0
  leds:
    led_01: (color1)
- time: +1
  leds:
    led_02: (color2)-f900ms
- time: +1
manual_advance:
- duration: -1
  leds:
    (leds): red
- duration: -1
  leds:
    (leds): lime
- duration: -1
  leds:
    (leds): blue
event_show:
- duration: 1
  events:
    - step1
- duration: 1
  events:
    - step2
- duration: 1
  events:
    - step3
show_player:
play_on_led1:
  on:
    key: on_led_01
    show_tokens:
      leds: led_01
play_on_led2:
  on:
    key: on_led2
    show_tokens:
      leds: led_02
stop_on_led1:
```



```
on_led_01: stop
stop_on_led2:
  on_led2: stop
play_test_show1: test_show1
play_with_priority:
  test_show1:
    priority: 15
play_with_speed:
  test_show1:
    speed: 2
play_with_start_step:
  test_show1:
    start_step: 2
play_with_neg_start_step:
  test_show1:
    start_step: -2
play_with_loops:
  test_show1:
    loops: 2
play_with_sync_ms_1000:
  test_show1:
    sync_ms: 1000
play_with_sync_ms_500:
  test_show1:
    sync_ms: 500
play_with_manual_advance:
  test_show1:
    manual_advance: True
pause_test_show1:
  test_show1:
    action: pause
resume_test_show1:
  test_show1:
    action: resume
play_show_assoc_tokens:
  show_assoc_tokens:
    speed: 1
  show_tokens:
    line1Num: tag1
    line1Color: red
stop_show_assoc_tokens:
  show_assoc_tokens:
    action: stop
test_mode_started:
  8linesweep:
    loops: 0
    speed: 1
  show_tokens:
    line1num: row0
    line1color: red
    line2num: row1
    line2color: orange
    line3num: row2
    line3color: yellow
    line4num: row3
```



```

    line4color: green
    line5num: row4
    line5color: blue
    line6num: row5
    line6color: indigo
    line7num: row6
    line7color: violet
    line8num: row7
    line8color: midnightblue
test_mode_stopped:
    8linesweep:
        action: stop
play_manual_advance:
    manual_advance:
        show_tokens:
            leds: led_01
advance_manual_advance:
    manual_advance: advance
advance_manual_step_back:
    manual_advance: step_back
queue_play:
    event_show:
        block_queue: True
        action: play
        loops: 0
play_with_emitted_events:
    test_show1:
        events_when_played: test_show1_played, test_show1_played2
        events_when_stopped: test_show1_stopped
        events_when_looped: test_show1_looped
        events_when_paused: test_show1_paused
        events_when_resumed: test_show1_resumed
        events_when_advanced: test_show1_advanced
        events_when_stepped_back: test_show1_stepped_back
        events_when_completed: test_show1_completed
stop_emitted_events_show:
    test_show1: stop
pause_emitted_events_show:
    test_show1: pause
resume_emitted_events_show:
    test_show1: resume
advance_emitted_events_show:
    test_show1: advance
step_back_emitted_events_show:
    test_show1: step_back
play_with_completed_event:
    test_show1:
        events_when_completed: test_show1_completed
        events_when_stopped: test_show1_stopped
        loops: 0

```

Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Note that there are multiple mode config examples here. You might not necessarily use more than one in your machine.

Listing 22.197: `your_machine_folder/modes/mode1/config/mode1.yaml`

```
#config_version=4
mode:
  start_events: start_mode1
  stop_events: stop_mode1
  priority: 200
  start_priority: 1
  game_mode: False
  stop_on_ball_end: false

show_player:
  mode_mode1_started:
    test_show1:
      loops: -1

  mode_mode1_stopped:
    test_show1:
      action: stop

shows:
  show_from_mode:
    - time: 0
      leds:
        (leds): red
    - time: 1
```

Listing 22.198: `your_machine_folder/modes/mode2/config/mode2.yaml`

```
#config_version=4
mode:
  start_events: start_mode2
  stop_events: stop_mode2
  priority: 300
  start_priority: 1
  stop_on_ball_end: false
  game_mode: False

show_player:
  mode_mode2_started: test_show2

  mode_mode2_stopped:
    test_show2:
      action: stop
```

Listing 22.199: `your_machine_folder/modes/mode3/config/mode3.yaml`

```
#config_version=4
mode:
  start_events: start_mode3
  stop_events: stop_mode3
  priority: 100
  start_priority: 1
```



```
stop_on_ball_end: false
game_mode: False

show_player:
  mode_mode3_started: test_show3

  mode_mode3_stopped:
    test_show3:
      action: stop
```

Show file examples

Here are some example show files that go along with the above config(s).

Note that there are multiple shows here.

Listing 22.200: [your_machine_folder/shows/8linesweep.yaml](#)

```
#show_version=4
- time: 0
  leds:
    (line1num): (line1color)
- time: +1s
  leds:
    (line1num): black
    (line2num): (line2color)
- time: +1s
  leds:
    (line2num): black
    (line3num): (line3color)
- time: +1s
  leds:
    (line3num): black
    (line4num): (line4color)
- time: +1s
  leds:
    (line4num): black
    (line5num): (line5color)
- time: +1s
  leds:
    (line5num): off
    (line6num): (line6color)
- time: +1s
  leds:
    (line6num): off
    (line7num): (line7color)
- time: +1s
  leds:
    (line7num): off
    (line8num): (line8color)
- time: +1s
  leds:
    (line8num): off
- time: +1s
```


Listing 22.201: `your_machine_folder/shows/myparentshow.yaml`

```
#show_version=4
- duration: -1
  shows:
    mychildshow:
      speed: 1
      loops: 0
```

Listing 22.202: `your_machine_folder/shows/test_show1.yaml`

```
# show_version=4
- time: 0
  leds:
    led_01: 006400
    led_02: CCCCCC
  lights:
    light_01: CC
    light_02: 78
  gis:
    gi_01: FF
- time: 1
  leds:
    led_01: DarkGreen
    led_02: Black
- time: 2
  leds:
    led_01: DarkSlateGray
    led_02: Tomato
  lights:
    light_01: FF
    light_02: 33
  gis:
    gi_01: 99
- time: +1
  leds:
    led_01: MidnightBlue-f500 ms
    led_02: DarkOrange-f0.5 s
  gis:
    gi_01: 33
- time: 4
  leds:
    led_01: Off-f800
    led_02: Off-f800
  lights:
    light_01: 00-f800
    light_02: 00-f800
  gis:
    gi_01: 00
- time: 6
```


Listing 22.203: `your_machine_folder/shows/test_show2.yaml`

```
# show_version=4
- time: 0
  triggers:
    play_sound:
      sound: test_1
      volume: 0.5
      loops: -1
  events:
    test_event:
    test_event2:
- time: 1
  triggers:
    play_sound:
      sound: test_2
- time: 2
  triggers:
    play_sound:
      sound: test_3
      volume: 0.35
      loops: 1
- time: 3
```

Listing 22.204: `your_machine_folder/shows/test_show3.yaml`

```
# show_version=4
- time: 0
  flashers: flasher_01
- time: 1
  coils:
    coil_01: pulse
- time: 2
  coils:
    coil_01:
      power: .45
- time: 3
```

Listing 22.205: `your_machine_folder/shows/on_demand/mychildshow.yaml`

```
#show_version=4
- time: 0
  events: test
```

slide (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.206: `your_machine_folder/config/test_slides.yaml`

```
#config_version=4

modes:
  - mode1

displays:
  display1:
    width: 401
    height: 301
  display2:
    width: 402
    height: 302
    default: true

slides:
  slide1:
    - type: text
      text: SLIDE TEST 1-1
      y: -50
      color: ff0000
      font_size: 50
    - type: text
      text: SLIDE TEST 1-2
      color: 00ff00
      font_size: 50
    - type: text
      text: SLIDE TEST 1-3
      y: 50
      color: 0000ff
      font_size: 50
  slide2:
    type: text
    text: SLIDE TEST 2-1
    color: 00ffff
    font_size: 50
  slide3:
    widgets:
      type: text
      text: SLIDE TEST 3-1
      color: 00ff00
      font_size: 50
  slide4:
    widgets:
      type: text
      text: SLIDE TEST 4-1
      color: ffff00
      font_size: 50
    transition: move_in
  slide5:
    widgets:
      type: text
      text: SLIDE TEST 5-1
```



```
    color: ffaa00
    font_size: 50
  transition:
    type: move_in
    direction: right
  slide6:
    background_color: ff0000ff
    opacity: 0.5
  widgets:
    type: text
    text: TEST BACKGROUND COLOR & OPACITY
```

Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Listing 22.207: `your_machine_folder/modes/model1/config/model1.yaml`

```
# config_version=4

mode:
  priority: 500

slides:
  model_slide1:
    type: text
    text: MODE 1 SLIDE 1
    x: 25%
    color: ffaa00
    font_size: 100
```

slide_frame (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.208: `your_machine_folder/config/test_slide_frame.yaml`

```
#config_version=4

displays:
  default:
    width: 400
    height: 300

slides:
  slide1:
    - type: slide_frame
      width: 200
```



```
height: 100
name: frame1
y: 50
x: 50
anchor_y: bottom
anchor_x: left
- type: text
  text: SLIDE FRAME IN SLIDE 1
  font_size: 20
  y: bottom
  anchor_y: bottom
slide2:
- type: text
  text: slide2
frame1_text:
- type: text
  text: SLIDE 1 IN FRAME
  color: lime
  font_size: 10
- type: rectangle
  width: 200
  height: 100
  color: 550000
frame1_text2:
- type: text
  text: SLIDE 2 IN FRAME
  color: black
  font_size: 10
- type: rectangle
  width: 200
  height: 100
  color: 00ff00

slide_player:
  show_slide1: slide1
  show_slide2: slide2
  show_frame_text:
    frame1_text:
      target: frame1
  show_frame_text2:
    frame1_text2:
      target: frame1
```

slide_player (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.209: your_machine_folder/config/test_slide_player.yaml

```
#config_version=4
modes:
  - mode1

displays:
  display1:
    height: 400
    width: 300
  display2:
    height: 400
    width: 300

slides:
  machine_slide_1:
    - type: text
      text: TEST SLIDE PLAYER - SLIDE 1
      color: ff0000
      font_size: 100
    - type: rectangle
      width: 400
      height: 300
      color: blue
  machine_slide_2:
    - type: text
      text: TEST SLIDE PLAYER - SLIDE 2
      color: ffaa00
      font_size: 100
    - type: rectangle
      width: 400
      height: 300
      color: purple
  machine_slide_3:
    - type: text
      text: TEST SLIDE PLAYER - SLIDE 3
      color: 00ff00
      font_size: 100
    - type: rectangle
      width: 400
      height: 300
      color: yellow
  machine_slide_4:
    - type: text
      text: TEST SLIDE PLAYER - SLIDE 4
      color: 0000ff
      font_size: 100
    - type: rectangle
      width: 400
      height: 300
      color: pink
  machine_slide_5:
    - type: text
      text: TEST SLIDE PLAYER - SLIDE 5
      color: ff00ff
```



```
    font_size: 100
  - type: rectangle
    width: 400
    height: 300
    color: green
machine_slide_6:
  - type: text
    text: BASE SLIDE
  - type: rectangle
    width: 400
    height: 300
    color: blue
machine_slide_7:
  widgets:
    - type: text
      text: EXPIRE 1s
      color: red
    - type: rectangle
      width: 400
      height: 300
      color: yellow
  expire: 1s
machine_slide_8:
  widgets:
    - type: text
      text: EXPIRE 1s
      color: purple
      y: 66%
    - type: text
      text: WITH TRANSITION OUT
      color: purple
      y: 33%
    - type: rectangle
      width: 400
      height: 300
      color: orange
  expire: 1s
  transition_out: wipe
machine_slide_9:
  widgets:
    - type: text
      text: TRANSITION IN
    - type: rectangle
      width: 400
      height: 300
      color: lime
  transition: move_in
machine_slide_10:
  widgets:
    - type: text
      text: WIDGET 1
  animations:
    flash_widget_1:
      - property: opacity
        value: 1
```



```
        duration: .25s
        - property: opacity
          value: 0
        duration: .25s
        repeat: yes

slide_player:
  show_slide_1: machine_slide_1
  show_slide_2:
    machine_slide_2:
      target: display1
  show_slide_3:
    machine_slide_3:
      target: display2
  show_slide_4: machine_slide_4
  show_slide_5: machine_slide_5
  show_slide_4_p200:
    machine_slide_4:
      priority: 200
  show_slide_1_force:
    machine_slide_1:
      force: true
  add_slide_5_dont_show:
    slide1:
      show: false
  anon_slide_dict:
    slide_6:
      type: text
      text: TEXT FROM SLIDE_PLAYER DICT
      color: ff00ff
      font_size: 15
  anon_slide_list:
    slide_7:
      - type: text
        text: TEXT FROM SLIDE_PLAYER LIST
        color: red
        font_size: 15
        y: 66%
      - type: text
        text: WIDGET 2
        color: purple
        font_size: 15
        y: 33%
  anon_slide_widgets:
    slide_8:
      widgets:
        - type: text
          text: TEXT FROM SLIDE_PLAYER WIDGET LIST
          color: green
          font_size: 15
          y: 66%
        - type: text
          text: WIDGET 2
          color: lime
          font_size: 15
```



```
y: 33%
target: display1
transition: move_in
base_slide_no_expire: machine_slide_6
new_slide_expire:
  machine_slide_1:
    expire: 1s
show_slide_7: machine_slide_7
show_slide_8: machine_slide_8
show_slide_9: machine_slide_9
show_slide_5_with_transition:
  machine_slide_5:
    transition: fade
show_slide_9_with_transition:
  machine_slide_9:
    transition: fade
slide_2_dont_show:
  machine_slide_2:
    show: no
remove_slide_4:
  machine_slide_4:
    action: remove
remove_slide_4_with_transition:
  machine_slide_4:
    action: remove
    transition: wipe
remove_slide_8:
  machine_slide_8:
    action: remove
remove_slide_8_fade:
  machine_slide_8:
    action: remove
    transition: fade
slide1_expire_1s:
  machine_slide_1:
    expire: 1s
slide2_expire_1s:
  machine_slide_2:
    expire: 1s
show_slide_with_animations:
  my_slide:
    widgets:
      - type: text
        text: WIDGET 1
    animations:
      flash_widget_2:
        - property: opacity
          value: 1
          duration: .25s
        - property: opacity
          value: 0
          duration: .25s
          repeat: yes
```


Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Listing 22.210: `your_machine_folder/modes/mode1/config/mode1.yaml`

```
# config_version=4

mode:
  priority: 500

slides:
  mode1_slide:
    type: text
    text: MODE 1 SLIDE 1
    color: 00ff00
    font_size: 100
  mode1_slide_2:
    type: text
    text: MODE 1 SLIDE 2
    color: 00ffff
    font_size: 150

slide_player:
  show_mode1_slide: mode1_slide
  show_mode1_slide_2:
    mode1_slide_2:
      priority: -350
```

smart_matrix (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.211: `your_machine_folder/config/config.yaml`

```
# config_version=4
hardware:
  rgb_dmd: smartmatrix

smartmatrix:
  port: com4
  baud: 3400000
```

smart_virtual_platform (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Note that there are multiple machine config examples here. They're just included to show different options. You wouldn't actually use more than one.

Listing 22.212: `your_machine_folder/config/test_smart_virtual.yaml`

```
#config_version=4

virtual_platform_start_active_switches:
  - trough1
  - trough2
  - trough3

smart_virtual:
  simulate_manual_plunger: True
  simulate_manual_plunger_timeout: 3s

coils:
  outhole:
    number: C09
    pulse_ms: 20
  trough:
    number: C10
    pulse_ms: 20
  trough2:
    number:
  plunger:
    number: 1
  device1:
    number: 2
  device2:
    number: 3
  coil1:
    number:
  coil3:
    number:
  coil4:
```



```
    number:
  device3_c:
    number:
  device4_c:
    number:

switches:
  switch1:
    number:
  switch2:
    number:
  switch3:
    number:
  start:
    number: 1
    tags: start
  outhole:
    number: 2
  trough1:
    number: 3
  trough2:
    number: 4
  trough3:
    number: 5
  plunger:
    number: 6
  playfield:
    number: 7
    tags: playfield_active
  device1_s1:
    number: 8
  device1_s2:
    number: 9
  device2_s1:
    number: 10
  device2_s2:
    number: 11
  device3_s:
    number: 12
  device4_s:
    number: 13
  trough2_1:
    number:
  trough2_2:
    number:
  trough2_3:
    number:
  plunger2:
    number:

drop_targets:
  left1:
    switch: switch1
  left2:
    switch: switch2
```



```

left3:
  switch: switch3
  reset_coil: coil3
  knockdown_coil: coil4

drop_target_banks:
  left_bank:
    drop_targets: left1, left2
    reset_coils: coil1
    reset_events:
      drop_target_bank_left_bank_down: 1s

ball_devices:
  outhole:
    tags: drain
    ball_switches: outhole
    eject_coil: outhole
    eject_targets: trough
    confirm_eject_type: target
    debug: true
  trough:
    tags: trough, home
    ball_switches: trough1, trough2, trough3
    eject_coil: trough
    eject_targets: plunger
    confirm_eject_type: target
    debug: true
  plunger:
    tags: ball_add_live, home
    ball_switches: plunger
    eject_coil: plunger
    debug: true
  device1:
    ball_switches: device1_s1, device1_s2
    eject_coil: device1
    eject_targets: device2
    confirm_eject_type: target
    tags: home # has to be home or attract will collect the balls
  device2:
    ball_switches: device2_s1 #, device2_s2
#   eject_coil: device2
#   eject_targets: device2
    confirm_eject_type: target
    mechanical_eject: true
  device3:
    tags: home
    entrance_switch: device3_s
    eject_coil: device3_c
    ball_capacity: 3
    auto_fire_on_unexpected_ball: False
    debug: true
  device4:
    tags: home
    entrance_switch: device4_s
    eject_coil: device4_c

```



```
ball_capacity: 3
entrance_switch_full_timeout: 500ms
auto_fire_on_unexpected_ball: False
debug: true

trough2:
  tags: drain, trough, home
  ball_switches: trough2_1, trough2_2, trough2_3
  eject_coil: trough2
  eject_targets: plunger2
  confirm_eject_type: target
  debug: true
plunger2:
  tags: ball_add_live
  ball_switches: plunger2
  mechanical_eject: True
  debug: true
```

Listing 22.213: `your_machine_folder/config/test_smart_virtual_initial.yaml`

```
#config_version=4

config: test_smart_virtual.yaml

virtual_platform_start_active_switches:
  - device1_s1
```

snux (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.214: `your_machine_folder/config/config.yaml`

```
#config_version=4

hardware:
  platform: virtual
  driverboards: wpc
  coils: snux

system11:
  ac_relay_delay_ms: 75
  ac_relay_driver: c_ac_relay

snux:
  flipper_enable_driver: c_flipper_enable_driver
  diag_led_driver: c_diag_led_driver
  platform:
```



```
coils:
  c_diag_led_driver:
    number: c24
    allow_enable: true
  c_flipper_enable_driver:
    number: c23
    allow_enable: true
  c_ac_relay:
    number: c25
    allow_enable: true
  c_side_a1:
    number: c11a
  c_side_a2:
    number: c12a
    hold_power: 4
  c_side_c1:
    number: c11c
  c_side_c2:
    number: c12c
    hold_power: 4
  c_virtual:
    number:
```

spike (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.215: `your_machine_folder/config/config.yaml`

```
#config_version=4

hardware:
  platform: spike

spike:
  port: /dev/ttyUSB0
  baud: 115200
  debug: True
  nodes: 0, 1, 8, 9, 10, 11
  poll_hz: 10

coils:
  c_test:
    number: 1-0
    pulse_ms: 100
    hold_power: 5
  c_flipper_main:
    number: 8-1
    hold_power: 5
  c_flipper_hold:
```



```
    number: 8-3
    allow_enable: True
c_pop:
    number: 8-10
    pulse_power: 4

matrix_lights:
    backlight:
        number: 0-0
    l_1_3:
        number: 1-3
    l_8_30:
        number: 8-40

switches:
    s_service:
        number: 0-13
    s_start:
        number: 1-11
    s_8_3:
        number: 8-3
    s_flipper:
        number: 8-13
    s_flipper_eos:
        number: 8-15
    s_pop:
        number: 8-4

autofire_coils:
    ac_pops:
        coil: c_pop
        switch: s_pop

flippers:
    f_test_single:
        main_coil: c_flipper_main
        activation_switch: s_flipper

    f_test_hold:
        main_coil: c_flipper_main
        hold_coil: c_flipper_hold
        activation_switch: s_flipper

    f_test_hold_eos:    # not generally recommended but spike can do it
        main_coil: c_flipper_main
        hold_coil: c_flipper_hold
        activation_switch: s_flipper
        use_eos: True
        eos_switch: s_flipper_eos
```


switch_controller (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.216: `your_machine_folder/config/config.yaml`

```
#config_version=4

switches:
  s_test:
    number: 1
  s_test_events:
    number: 2
    events_when_activated: test_active|100ms, test_active2
    events_when_deactivated: test_inactive, test_inactive2|2s
  s_test_window_ms:
    number: 3
    ignore_window_ms: 100ms
  s_test_invert:
    number: 4
    type: 'NC'
```

switch_player (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.217: `your_machine_folder/config/config.yaml`

```
#config_version=4

switches:
  s_test1:
    number:
  s_test2:
    number:
  s_test3:
    number:

plugins: switch_player

switch_player:
  start_event: test_start
  steps:
    - time: 100ms
      switch: s_test1
      action: activate
```



```
- time: 600ms
  switch: s_test3
  action: hit
- time: 100ms
  switch: s_test1
  action: deactivate
- time: 1s
  switch: s_test2
  action: activate
- time: 1s
  switch: s_test3
  action: hit
- time: 100ms
  switch: s_test2
  action: deactivate
- time: 1s
  switch: s_test3
  action: hit
```

text (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.218: `your_machine_folder/config/test_text.yaml`

```
#config_version=4

modes:
  - mode1

displays:
  default:
    width: 400
    height: 300

slides:
  static_text:
    - type: text
      text: TEST
    - type: text
      text: STATIC TEXT
      y: 200
  text_from_event_param1:
    - type: text
      text: (param1)
    - type: text
      text: TEXT FROM EVENT PARAMETER
      y: 200
      color: red
  text_from_event_param2:
```



```
- type: text
  text: HI (param1)
- type: text
  text: MIX STATIC AND DYNAMIC FROM EVENT
  y: 200
  color: orange
text_from_event_param3:
- type: text
  text: MIX (param1) MATCH
- type: text
  text: MIX STATIC SURROUNDING DYNAMIC
  y: 200
  color: yellow
text_from_event_param4:
- type: text
  text: NO(param1)
- type: text
  text: MIX WITH NO SPACE
  y: 200
  color: green
text_from_event_param5:
- type: text
  text: NUMBER (param1)
- type: text
  text: DYNAMIC INTEGER
  y: 200
  color: lightblue
text_from_event_param6:
- type: text
  text: (param1)
- type: text
  text: PURELY DYNAMIC NO MIX
  y: 200
  color: blue
text_from_event_param7:
- type: text
  text: 1)
- type: text
  text: PARENTHESIS IN STRING
  y: 200
  color: pink
text_from_event_param8:
- type: text
  text: ((param1))
- type: text
  text: COMBINE PARENTHESIS AND DYNAMIC
  y: 200
  color: purple

text_with_player_var1:
- type: text
  text: (test_var)
  font_size: 100
- type: text
  text: TESTING WIDGET AUTO UPDATE
```



```
    y: 90
    color: pink
  - type: text
    text: FROM PLAYER VAR
    y: 70
    color: pink
text_with_player_var2:
  - type: text
    text: (player|test_var)
  - type: text
    text: DEFAULT PLAYER
    y: 200
    color: red
text_with_player_var3:
  - type: text
    text: (player1|test_var)
  - type: text
    text: NAMED PLAYER
    y: 200
    color: blue
text_with_player_var4:
  - type: text
    text: (player2|test_var)
  - type: text
    text: NAMED PLAYER THAT DOESN'T EXIST
    y: 200
    color: brown
text_with_player_var_and_event:
  - type: text
    text: (player_var) (test_param)
  - type: text
    text: MIX EVENT PARAM AND PLAYER VAR
    y: 200
    color: orange

text_string1:
  - type: text
    text: $greeting
  - type: text
    text: TEST text_string
    y: 200
    color: green
text_string2:
  - type: text
    text: $greeting $name
  - type: text
    text: TEST 2 text_strings
    y: 200
    color: purple
text_string3:
  - type: text
    text: $money
  - type: text
    text: TEST text_string without dollar sign
    y: 200
```



```
    color: red
text_string4:
  - type: text
    text: $$dollar
  - type: text
    text: TEST text_string with dollar sign
    y: 200

number_grouping:
  - type: text
    text: 0
    min_digits: 2
    number_grouping: yes
  - type: text
    text: TEST NUMBER GROUPING & DOUBLE ZEROS
    y: 200

mpfmc_font:
  - type: text
    text: MPF-MC FONT TEST
    font_name: pixelmix

machine_font:
  - type: text
    text: TEST FONT FROM MACHINE FOLDER
    font_name: big_noodle_titling
baseline:
  - type: text
    text: aaa
    x: 50
    y: 100
    anchor_y: bottom
  - type: text
    text: aaa
    x: 150
    y: 100
    anchor_y: baseline
  - type: text
    text: yyy
    x: 250
    y: 100
    anchor_y: bottom
  - type: text
    text: yyy
    x: 350
    y: 100
    anchor_y: baseline
  - type: line
    points: 0, 100, 800, 100
    color: red

slide_player:
  static_text: static_text
  text_from_event_param1: text_from_event_param1
  text_from_event_param2: text_from_event_param2
```



```
text_from_event_param3: text_from_event_param3
text_from_event_param4: text_from_event_param4
text_from_event_param5: text_from_event_param5
text_from_event_param6: text_from_event_param6
text_from_event_param7: text_from_event_param7
text_from_event_param8: text_from_event_param8
text_with_player_var1: text_with_player_var1
text_with_player_var2: text_with_player_var2
text_with_player_var3: text_with_player_var3
text_with_player_var4: text_with_player_var4
text_with_player_var_and_event: text_with_player_var_and_event
number_grouping: number_grouping
text_string1: text_string1
text_string2: text_string2
text_string3: text_string3
text_string4: text_string4
mpfmc_font: mpfmc_font
machine_font: machine_font
baseline: baseline

text_strings:
  greeting: HELLO
  ball: (ball)
  name: PLAYER
  dollar: 100
```

Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Listing 22.219: `your_machine_folder/modes/model/config/model1.yaml`

```
#config_version=4

mode:
  priority: 100

text_strings:
  greeting: HELLO FROM MODE 1

slides:
  text_string1_model1:
    - type: text
      text: $greeting

slide_player:
  text_string1_model1: text_string1_model1
```

text_input (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.220: `your_machine_folder/config/text_input.yaml`

```
#config_version=4

displays:
  default:
    width: 400
    height: 300

slides:
  slide1:
    - type: text
      text: TEXT HIGH SCORE ENTRY
      color: red
      y: top-5
      anchor_y: top
    - type: text_input
      initial_char: C
      key: key1
      style: score_entry
      animations:
        show_slide:
          - property: opacity
            value: 1
            duration: .25s
          - property: opacity
            value: 0
            duration: .25s
```



```
      repeat: yes
-   type: text
    text: ""
    key: key1
    style: score_entry

widget_styles:
  score_entry:
    font_size: 50

slide_player:
  slide1: slide1
```

tilt (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.221: `your_machine_folder/config/config.yaml`

```
#config_version=4

modes:
  - tilt

game:
  balls_per_game: 2

coils:
  eject_coil1:
    number:
  eject_coil2:
    number:
  c_flipper:
    number:

switches:
  s_start:
    number:
    tags: start
  s_ball_switch1:
    number:
  s_ball_switch2:
    number:
  s_ball_switch_launcher:
    number:
  s_tilt:
    number:
    tags: tilt
  s_tilt_warning:
    number:
```



```
    tags: tilt_warning
  s_slam_tilt:
    number:
    tags: slam_tilt
  s_flipper:
    number:

ball_devices:
  bd_trough:
    eject_coil: eject_coil1
    ball_switches: s_ball_switch1, s_ball_switch2
    debug: true
    confirm_eject_type: target
    eject_targets: bd_launcher
    tags: trough, drain, home
  bd_launcher:
    eject_coil: eject_coil2
    ball_switches: s_ball_switch_launcher
    debug: true
    confirm_eject_type: target
    eject_timeouts: 6s, 10s
    tags: ball_add_live

flippers:
  f_test:
    main_coil: c_flipper
    activation_switch: s_flipper
```

Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Listing 22.222: `your_machine_folder/modes/tilt/config/tilt.yaml`

```
#config_version=4

tilt:
  tilt_warning_switch_tag: tilt_warning
  tilt_switch_tag: tilt
  slam_tilt_switch_tag: slam_tilt
  warnings_to_tilt: 3
  reset_warnings_events: ball_ended
  multiple_hit_window: 300ms
  settle_time: 5s
  tilt_warnings_player_var: tilt_warnings
  tilt_slam_tilt_events: slam_tilt_event
  tilt_warning_events: tilt_warning_event
  tilt_events: tilt_event
```

timed_switches (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.223: `your_machine_folder/config/timed_switches.yaml`

```
#config_version=4

switches:
  switch1:
    number:
  switch2:
    number:
  switch3:
    number:
  switch4:
    number:
    tags: left_flipper
  switch5:
    number:
    tags: right_flipper

timed_switches:
  group1:
    switches: switch1, switch2
    time: 2s
  another_one:
    switches: switch3
    time: 2000ms
    state: inactive
    events_when_active: active_event
    events_when_released: release_event
```


timer (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.224: [your_machine_folder/config/test_timer.yaml](#)

```
#config_version=4

modes:
  - mode_with_timers
  - mode_with_timers2
```

Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Note that there are multiple mode config examples here. You might not necessarily use more than one in your machine.

Listing 22.225: [your_machine_folder/modes/mode_with_timers/config/mode_with_timers.yaml](#)

```
#config_version=4
mode:
  start_events: start_mode_with_timers
  stop_events: stop_mode_with_timers
  game_mode: false
timers:
  timer_down:
    debug: True
    bcp: True
    start_value: 5
    end_value: 0
    direction: down
    tick_interval: 1.5s
    start_running: no
    control_events:
      - event: start_timer_down
        action: start
      - event: reset_timer_down
        action: reset
      - event: pause_timer_down
        action: pause
        value: 2
      - event: add_timer_down
        action: add
        value: 2
      - event: subtract_timer_down
        action: subtract
        value: 2
  timer_start_running:
    debug: True
```



```
    start_value: 0
    end_value: 10
    direction: up
    tick_interval: 1s
    start_running: yes
timer_restart_on_complete:
    debug: True
    start_value: 0
    end_value: 5
    direction: up
    tick_interval: 1s
    start_running: yes
    restart_on_complete: yes
timer_up:
    bcp: True
    debug: True
    start_value: 0
    end_value: 10
    max_value: 15
    direction: up
    tick_interval: 1s
    start_running: no
    control_events:
        - event: start_timer_up
          action: start
        - event: reset_timer_up
          action: reset
        - event: stop_timer_up
          action: stop
        - event: restart_timer_up
          action: restart
        - event: jump_timer_up
          action: jump
          value: 5
        - event: jump_over_max_timer_up
          action: jump
          value: 20
        - event: add_timer_up
          action: add
          value: 2
        - event: change_tick_interval_timer_up
          action: change_tick_interval
          value: 4
        - event: set_tick_interval_timer_up
          action: set_tick_interval
          value: 2
        - event: reset_tick_interval
          action: reset_tick_interval
timer_player_var:
    debug: True
    start_value: current_player.start
    end_value: current_player.end
    direction: up
    tick_interval: 1s
    start_running: yes
```


Listing 22.226: `your_machine_folder/modes/mode_with_timers2/config/mode_with_timers2.yaml`

```
#config_version=4
mode:
  start_events: game_started
  stop_events: stop_mode_with_timers2
timers:
  timer_start_with_game:
    debug: True
    start_value: 0
    end_value: 10
    direction: up
    tick_interval: 1s
    start_running: yes
```

transitions (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.227: `your_machine_folder/config/test_transitions.yaml`

```
# config_version=4

displays:
  default:
    width: 400
    height: 300

slides:
  slide1:
    - type: text
      text: TRANSITION TEST
      y: 33%
      color: ff0000
      font_size: 50
    - type: text
      text: ===== SLIDE 1 =====
      y: 66%
      color: ff0000
      font_size: 50
    - type: rectangle
      width: 400
      height: 300
      color: 330000

  slide2:
    - type: text
      text: TRANSITION TEST
      color: 00ff00
      font_size: 50
```



```
    y: 33%
  - type: text
    text: ----- SLIDE 2 -----
    color: 00ff00
    font_size: 50
    y: 66%
  - type: rectangle
    width: 400
    height: 300
    color: 003300

slide_player:
  show_slide1: slide1
  show_slide2:
    slide2:
      transition:
        type: push
        easing: out_bounce
        duration: 2s
        direction: right
  push_left:
    slide2:
      transition:
        type: push
        direction: left
  push_right:
    slide2:
      transition:
        type: push
        direction: right
  push_up:
    slide2:
      transition:
        type: push
        direction: up
  push_down:
    slide2:
      transition:
        type: push
        direction: down
  move_in_left:
    slide2:
      transition:
        type: move_in
        direction: left
  move_in_right:
    slide2:
      transition:
        type: move_in
        direction: right
  move_in_top:
    slide2:
      transition:
        type: move_in
        direction: top
```



```
move_in_bottom:
  slide2:
    transition:
      type: move_in
      direction: bottom
move_out_left:
  slide2:
    transition:
      type: move_out
      direction: left
move_out_right:
  slide2:
    transition:
      type: move_out
      direction: right
move_out_top:
  slide2:
    transition:
      type: move_out
      direction: top
move_out_bottom:
  slide2:
    transition:
      type: move_out
      direction: bottom
wipe:
  slide2:
    transition:
      type: wipe
swap:
  slide2:
    transition:
      type: swap
fade:
  slide2:
    transition:
      type: fade
fade_back:
  slide2:
    transition:
      type: fade_back
rise_in:
  slide2:
    transition:
      type: rise_in
# no_transition_1:
#   slide2
#   transition: None
# no_transition_2:
#   slide2
#   transition: false
# no_transition_3:
#   slide2
#   transition:
#     type: none
```



```
show_slide1_with_push:
  slide1:
    transition:
      type: push
      direction: right
show_slide2_no_transition: slide2
```

utils (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.228: [your_machine_folder/config/test_utils.yaml](#)

```
#config_version=4

slides:
  slide1:
    - type: text
      text: widget1
      z: 100
    - type: text
      text: widget2
      z: 50
    - type: text
      text: widget3

slide_player:
  show_slide1:
    slide: slide1
```

video (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.229: [your_machine_folder/config/test_video.yaml](#)

```
#config_version=4

displays:
  default:
    width: 400
    height: 300
```



```
modes:
  - mode1

slides:
  video_test:
    - type: video
      video: mpf_video_small_test
    - type: text
      text: Video Test
      y: bottom+20%
    - type: text
      text: ""
      y: bottom+10%
  video_test2:
    - type: video
      video: mpf_video_small_test
      control_events:
        - event: play1
          action: play
        - event: stop1
          action: stop
        - event: pause1
          action: pause
        - event: seek1
          action: seek
          value: .5
        - event: position1
          action: position
          value: 4
        - event: mute
          action: volume
          value: 0
    - type: text
      text: Video Control Events Test
      y: bottom+20%
    - type: text
      text: ""
      y: bottom+10%
  video_test3:
    - type: video
      video: mpf_video_small_test
      control_events:
        - event: pre_show_slide
          action: seek
          value: .5
  video_test4:
    - type: video
      video: mpf_video_small_test
      control_events:
        - event: show_slide
          action: seek
          value: .5
  video_test5:
    - type: video
      video: mpf_video_small_test
```



```
control_events:
  - event: pre_slide_leave
    action: seek
    value: .5
video_test6:
  - type: video
    video: mpf_video_small_test
    control_events:
      - event: slide_leave
        action: seek
        value: .5
video_test7:
  - type: video
    video: mpf_video_small_test
    auto_play: true
    end_behavior: loop
    volume: .2
    control_events:
      - event: seek1
        action: seek
        value: .9
video_test8:
  - type: video
    video: mpf_video_small_test
    auto_play: false
    end_behavior: stop
    volume: 0.8
    control_events:
      - event: play1
        action: play
      - event: seek1
        action: seek
        value: .9
video_test9:
  - type: text
    text: Machine slide, no video

slide_player:
  show_slide1: video_test
  show_slide2: video_test2
  show_slide3: video_test3
  show_slide4: video_test4
  show_slide5: video_test5
  show_slide6: video_test6
  show_slide7: video_test7
  show_slide8: video_test8
  show_slide9: video_test9

videos:
  mpf_video_small_test:
    width: 100
    height: 70
```


Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Listing 22.230: `your_machine_folder/modes/mode1/config/mode1.yaml`

```
#config_version=4

mode:
  priority: 100

slide_player:
  mode_mode1_started:
    mode1_slide1:
      widgets:
        - type: video
          video: mpf_video_small_test
        - type: text
          text: Video from Mode
          y: bottom+20%
```

widget_styles (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.231: `your_machine_folder/config/test_widget_styles.yaml`

```
#config_version=4

modes:
  - mode1

displays:
  default:
    width: 400
    height: 300

widget_styles:
  text_default:
    font_size: 21
    color: red
  bigStyle:
    font_size: 100
    halign: left

slides:
  slide1:
    - type: text
      text: HELLO
```



```
    style: bigStyle
    halign: right
  - type: text
    text: Default Style
    y: 100
slide3:
  - type: text
    font_size: 30
    text: COLOR FROM DEFAULT STYLE
slide4:
  - type: text
    text: TESTING INVALID STYLE
    style: bogus
slide5:
  - type: text
    text: HELLO
    style: bigStyle
    font_size: 50

slide_player:
  slide1: slide1
  slide3: slide3
  slide4: slide4
  slide5: slide5
```

Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Listing 22.232: `your_machine_folder/modes/mode1/config/mode1.yaml`

```
#config_version=4

mode:
  priority: 100

widget_styles:
  text_default:
    font_size: 50

slides:
  slide2:
    - type: text
      text: MODE1 DEFAULT STYLE
      y: 75
    - type: text
      style: big
      text: BIG FROM BASE
      y: 225

slide_player:
  slide2: slide2
```


widgets (example config files)

Machine config examples

Here are some example machine-wide config files that show real-world examples of how these configs are used.

Listing 22.233: `your_machine_folder/config/test_widgets.yaml`

```
#config_version=4

modes:
- model

displays:
  default:
    width: 400
    height: 300

widgets:
  widget1:
    type: text
    text: widget1
    color: ffff00
    font_size: 100
    y: top-40%
  widget2:
    - type: text
      text: widget2
      y: 50
      color: ff0000
      font_size: 100
  widget3:
    - type: text
      text: widget3.1
      color: ff0000
      font_size: 100
    - type: text
      text: widget3.2
      color: 00ff66
      font_size: 100
    - type: text
      text: widget3.3
      color: ff00ff
      font_size: 100
  widget4:
    - type: text
      text: widget4.1
      y: 300
      z: 1
      color: ff0000
      font_size: 100
    - type: text
      text: widget4.2
```



```
z: 1000
y: 250
color: ffff00
font_size: 100
- type: text
  text: widget4.3
  y: 200
  color: 00ff00
  font_size: 100
- type: text
  text: widget4.4
  z: 1
  y: 150
  color: 00ffff
  font_size: 100
- type: text
  text: widget4.5
  z: 1000
  y: 100
  color: 0000ff
  font_size: 100
- type: text
  text: widget4.6
  color: ff00ff
  font_size: 100
  y: 50
- type: text
  text: widget4.7
  y: 0
  color: 888888
  font_size: 100
widget5:
  type: text
  text: widget5
  z: 200
  y: 150
  font_size: 100
widget6:
  type: text
  text: widget6
  z: 100
  color: 774303
  font_size: 100
widget7:
  type: text
  text: EXPIRES 1S
  color: orange
  font_size: 100
  expire: 1s
widget8:
  type: text
  text: WIDGET 8
  color: orange
  font_size: 100
box11:
```



```
- type: text
  text: box11
box12:
- type: text
  text: box12
box13:
- type: text
  text: box13
box14:
- type: text
  text: box14
widget9:
- type: text
  text: named_widget9
  key: widget9_key
widget10:
  type: text
  text: (text)
info_frame:
- type: slide_frame
  width: 210
  height: 28
  name: infoframe
  y: 28
  x: 0
  anchor_y: top
  anchor_x: left
  z: 1000

widget_player:
  add_widget1_to_current: widget1
  add_widget2_to_current: widget2
  add_widget2_to_slide1:
    widget2:
      slide: slide1
  add_widget6:
    widget6:
      target: default
  remove_widget1_by_key:
    widget1:
      action: remove
      key: widget1
  remove_widget1:
    widget1:
      action: remove
  add_widget7: widget7
  add_widget8_expire:
    widget8:
      widget_settings:
        expire: 1s
  add_widget8_expire_parent:
    widget8:
      widget_settings:
        expire: 1s
        target: default
```



```
add_widget8_custom_settings:
  widget8:
    widget_settings:
      color: red
      font_size: 70
      x: right-10
      anchor_x: right
add_widget8_opacity_50:
  widget8:
    widget_settings:
      opacity: .5
      text: 50% OPACITY
      font_size: 50
  widget1:
    action: add
event_a:
  widget1:
    action: update
    widget_settings:
      text: A
      color: red
event_s:
  widget1:
    action: update
    widget_settings:
      text: S
      color: lime
event_d:
  widget1:
    action: update
    widget_settings:
      text: D
      color: blue
widget_4up:
  box14:
    widget_settings:
      x: 25
      expire: 6s
  box13:
    widget_settings:
      x: 105
      expire: 6s
  box12:
    widget_settings:
      x: 185
      expire: 6s
  box11:
    widget_settings:
      x: 265
      expire: 6s
widget_4up_red:
  box14:
    widget_settings:
      color: red
  box13:
```



```
    widget_settings:
      color: red
box12:
  widget_settings:
    color: red
box11:
  widget_settings:
    color: red
widget_to_parent:
  box11:
    target: default
    widget_settings:
      z: 1
  box12:
    widget_settings:
      z: 2
      color: red
      y: middle+2
show_christmas_slide_full:
  widget2:
    widget_settings:
      expire: 5s
      slide: slide1
      key: xmas_intro_keyname
remove_christmas_full:
  widget2:
    action: remove
    key: xmas_intro_keyname
show_widget9:
  widget9:
    key: widget9_wp_key
show_widget10:
  widget10:
    action: add
show_info_frame:
  info_frame: {}

slide_player:
  show_slide_1:
    slide_1:
      - type: text
        text: WIDGET WITH KEY
        key: widget1
        color: red
        y: 33%
      - type: text
        text: WIDGET NO KEY
        color: red
        y: 66%
  show_slide_1_with_expire:
    slide_1:
      - type: text
        text: WIDGET EXPIRE 1s
        expire: 1s
        color: red
```



```
    y: 33%
  - type: text
    text: WIDGET NO EXPIRE
    color: red
    y: 66%
show_slide_2:
  slide_2:
  - type: text
    text: TEST UPDATING EXISTING WIDGET SETTINGS
    y: bottom
    anchor_y: bottom
show_slide_3:
  slide_3:
    widgets:
  - type: text
    text: WIDGET REPLACEMENT
    y: 25%
show_slide_with_widgets:
  slide_1:
  - type: text
    text: widget4.1
    y: 300
    z: 1
    color: ff0000
    font_size: 100
  - type: text
    text: widget4.2
    z: 1000
    y: 250
    color: ffff00
    font_size: 100
  - type: text
    text: widget4.3
    y: 200
    color: 00ff00
    font_size: 100
  - type: text
    text: widget4.4
    z: 1
    y: 150
    color: 00ffff
    font_size: 100
  - type: text
    text: widget4.5
    z: 1000
    y: 100
    color: 0000ff
    font_size: 100
  - type: text
    text: widget4.6
    color: ff00ff
    font_size: 100
    y: 50
  - type: text
    text: widget4.7
```



```
    y: 0
    color: 888888
    font_size: 100
show_slide_with_lots_of_widgets: slide_with_lots_of_widgets
show_new_slide:
  new_slide2:
    widgets:
      - type: text
        text: NEW SLIDE
        y: 0
        anchor_y: bottom

slides:
  slide_with_lots_of_widgets:
    - type: text
      text: widget4.1
      y: 300
      z: 1
      color: ff0000
      font_size: 100
    - type: text
      text: widget4.2
      z: 1000
      y: 250
      color: ffff00
      font_size: 100
    - type: text
      text: widget4.3
      y: 200
      color: 00ff00
      font_size: 100
    - type: text
      text: widget4.4
      z: 1
      y: 150
      color: 00ffff
      font_size: 100
    - type: text
      text: widget4.5
      z: 1000
      y: 100
      color: 0000ff
      font_size: 100
    - type: text
      text: widget4.6
      color: ff00ff
      font_size: 100
      y: 50
    - type: text
      text: widget4.7
      y: 0
      color: 888888
      font_size: 100
```


Mode config examples

Here are some example mode config files that go along with the machine-wide config above.

Listing 22.234: [your_machine_folder/modes/mode1/config/mode1.yaml](#)

```
# config_version=4

mode:
  priority: 500

widget_player:
  mode1_add_widgets: widget2
  mode1_add_widget6:
    widget6:
      target: default
  mode1_add_widget_with_key:
    widget2:
      key: newton_crosby
  mode1_update_widget2:
    widget2:
      action: update
      key: newton_crosby
  widget_settings:
    text: UPDATED TEXT
```

Example Machine Projects you can learn from

The mpf-examples project

Contains several examples of MPF configs you can run and learn from, including:

- *Demo Man*
- *MC Demo*
- *Cookbook recipes*
- *Tutorial config files*

Full details about the mpf-examples project and how to download it are [here](#).

State Fair Pinball

An upcoming machine we're working on. Details: <http://statefairpinball.com>. GitHub repo: https://github.com/missionpinball/state_fair

Brooks 'n Dunn

One of the projects we took on in 2015 was to rewire and build and MPF config for Gottlieb's Brooks 'n Dunn. (BnD). BnD was the machine that Gottlieb was working on when they shut down in 1996.

This config is probably the most complete of any MPF project that's publicly available. However it contains lots of licensed assets (music, videos, images, etc.) that are not in the public repo. This means you won't be able to actually run it, but you can look through the configs (which are well commented) to see how we do things.

The BnD repo is at <https://github.com/gabeknuth/bnd>

How to download the mpf-examples bundle

We maintain a GitHub repo called [mpf-examples](#) which contains a few different example MPF configs and some templates you can use.

The mpf-examples repo doesn’t have an installer; rather, you just download it and unzip it and start using the stuff it contains.

Each software repo in GitHub has several “branches”. (Think of branches kind of like versions.) The mpf-examples repo has multiple branches that each match a specific version of MPF. For example, the 0.21 branch of the mpf-examples repo is for MPF 0.21, the 0.30 branch is for MPF 0.30, etc.

Here are the direct links (to ZIP files) for the various branches of mpf-examples that you can download based on your version of MPF:

- [0.21.x](#).
- [0.30.x](#).
- [0.31.x](#).
- [0.32.x](#).
- [0.33.x](#).
- [dev](#).

Unzip the file to any location you want, and then browse the files to see what’s there, or open a console window to launch MPF and/or MPF MC in each folder.

demo_man

Williams Demolition Man. This config is pretty basic, but you can play complete games and it has some simple shots, scoring, and modes. It also contains custom code to run the Cryro Claw. See details which explain how to “play” this game on your computer [here](#).

mc_demo

A machine config that demonstrates several capabilities of the MPF Media Controller (MPF-MC). Details [here](#).

tutorial (and several tutorial_step_XX folders)

Contains the config files used in the [MPF Tutorial](#).

wpc_template

A template config you can use for WPC machines (with either a P-ROC or FAST WPC controller).

How to run “Demo Man”, an MPF example game

One of the development machines we have for MPF is a 1994 Williams *Demolition Man*, and we have a simple MPF configuration built for it that you can run to see MPF in action.

Even if you don’t have a physical *Demolition Man* machine (which we assume you don’t), you can run our “Demo Man” config using MPF’s [smart virtual](#) platform.

1. Download the MPF examples bundle

Instructions [here](#).

2. Run *Demo Man*, a sample game that comes with MPF

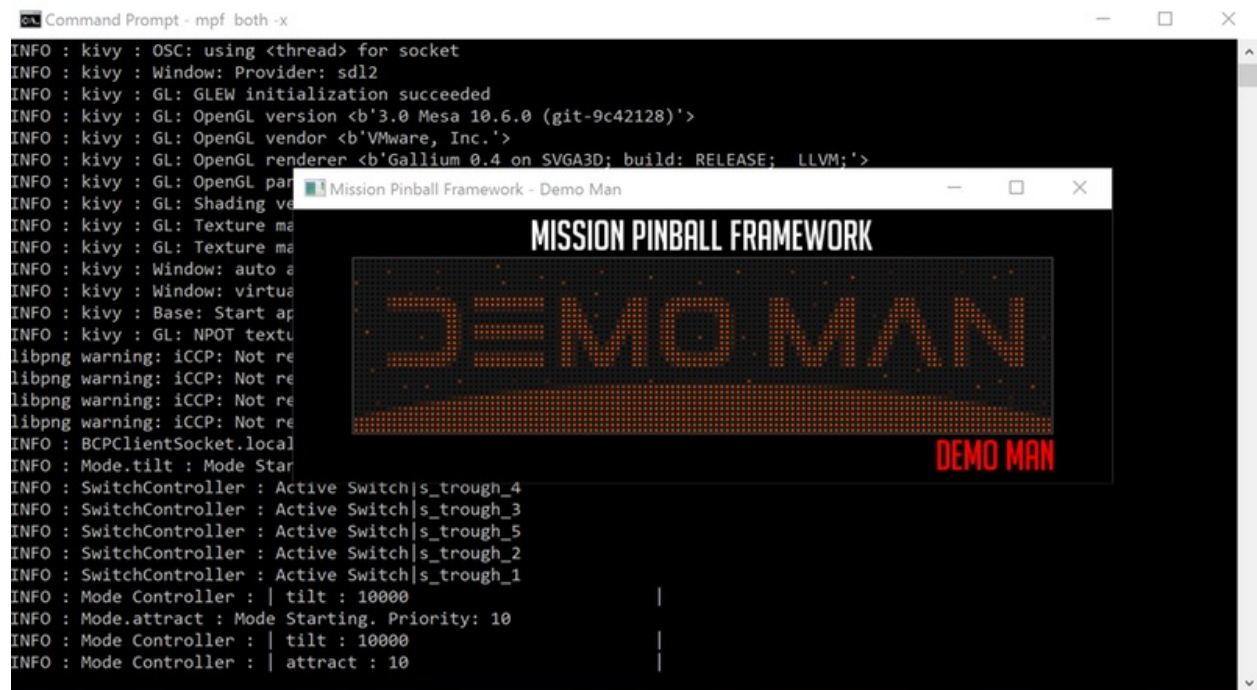
Open a command prompt (like you did when you installed MPF) and switch to the folder where you unzipped the mpf-examples ZIP file, then change to the demo_man folder and run:

```
mpf both -X
```

(Note that’s an uppercase “X”)

The `mpf both` command launches both the MPF game engine and media controller at the same time, the `-X` command line option tells MPF to use the “Smart Virtual” platform (instead of the P-ROC platform that the Demo Man files are configured for) since you most likely don’t have a Demolition Man machine connected to your computer right now.

You should see a bunch of stuff scroll by and a pop up window which shows the Demo Man DMD, like this:



If you don’t see the DMD window pop up, make sure it isn’t hiding behind another window.

3. “Play” your first game

Since you don’t have physical hardware attached, you can use the keyboard to simulate machine switch changes.

The *Demo Man* configuration files have the “S” key mapped to start, so if you click in the graphical window with the DMD in it (to give it focus) and push the S key, then you should see the DMD attract mode stop and it change to a score screen showing a score of *00* and *BALL 1 FREE PLAY*:

If your speakers are on you should also hear a music loop playing. (Depending on your system, you might not hear the music when the DMD window doesn't have focus.)

At this point you can “play” the game via your keyboard. Hit the L key to launch the ball into play. You should hear the music loop change to the main background music.

You can hit the X key to simulate the left slingshot hit which should play a sound effect on top of the music as well as show a score. You can hit the 1 key to simulate the ball draining and entering the trough. Then you can hit the L key again to launch the ball into play again. You can also press the S key additional times during Ball 1 to add additional players.

When you play through a complete game (3 balls per player), the machine should go back into attract mode (or possibly the high score entry mode).

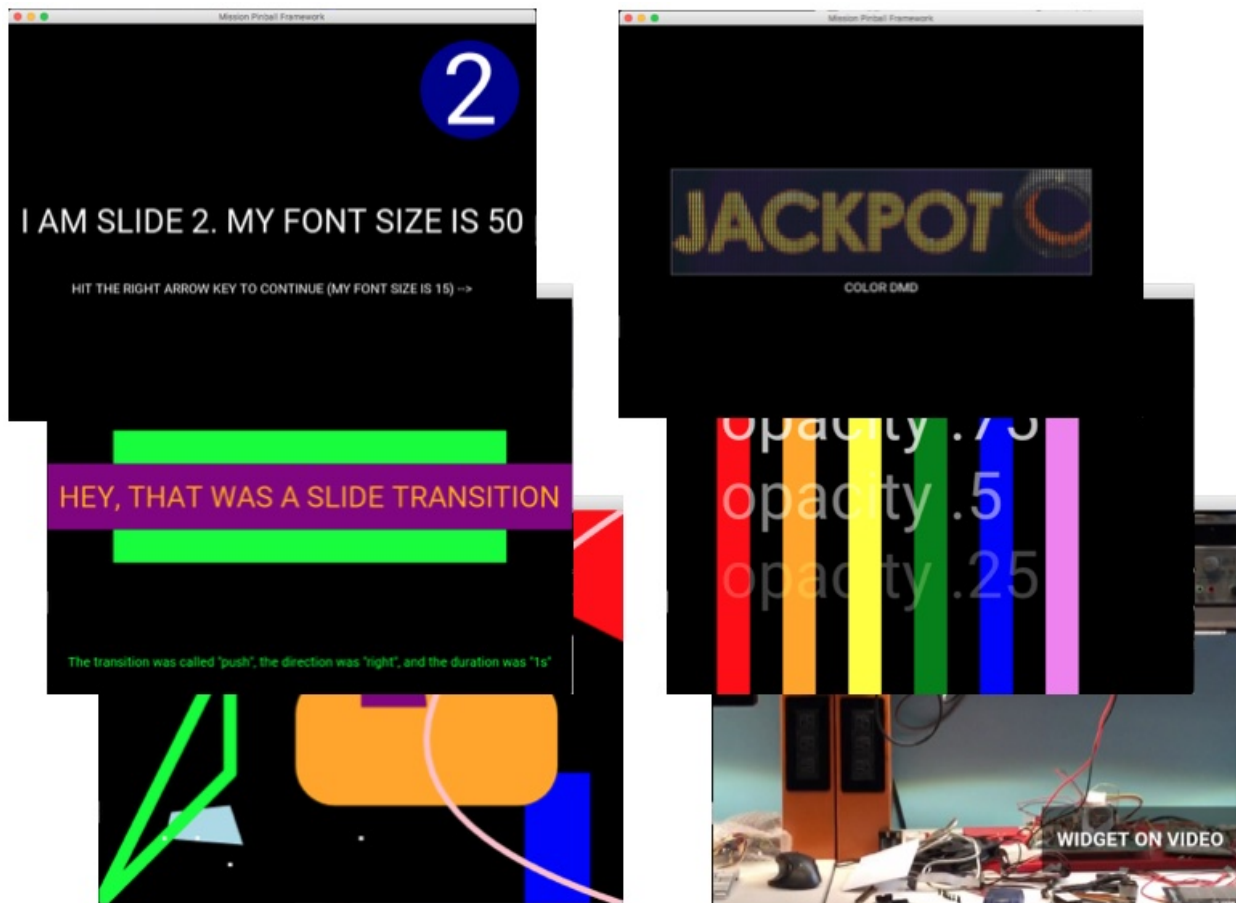
You can quit the game by making sure the *Demo Man* popup window is in focus and hitting the *Esc* key.

To summarize the instructions for “playing” a game from the paragraphs above:

1. Launch both the MPF core engine and the media controller and make sure you see the the popup graphical window with the DMD in it.
2. Click the mouse into the DMD window so that it has “focus”
3. Press the S key to start a game. You should hear the music loop start.
4. Press the L key to launch a ball into play. You should hear the music switch to the main background theme for the game.
5. Press the X key a few times to simulate hitting the left slingshot. You should see the score change each time you do this.
6. Press the 1 key to drain the ball.
7. Repeat Steps 4-6 until you finish your game or get bored.
8. If you get a high score, the Z and / keys are mapped to the left and right flipper buttons to highlight a letter, and the S key (start) selects it.
9. Press the Esc key to exit

How to run the “MC Demo” example

The [MPF Examples](#) GitHub repository includes a machine configuration called “MC Demo” which is a demo of many different features of the MPF media controller. Here are a few random screen shots of it:



You can run it and use the arrow keys on your computer to step through different slides, and then you can look at the source config file to see how it all works.

It's designed to both show you what's possible and to show you how to do different things with the MC.

1. Download the MPF examples bundle

Instructions [here](#).

2. Run it

Open a command prompt or terminal window, and change to the “mc_demo” folder in the “mpf-examples” package you downloaded. Then run:

```
mpf both
```

When you run the demo, use the left and right arrow keys to step through the different slides.

3. Check out the config (with notes!)

You can browse the complete config in the mc_demo/config/config.yaml file. Or check it out online [here](#).

CHAPTER 24

The MPF Cookbook

The MPF cookbook contains recipes (how to guides) which show you how you would implement features from real pinball machines using MPF.

If you've ever played a game and wondered, "How would I do that?" then let us know and we'll write a recipe for it!

Here are the recipes that are done:

- *The Addams Family: Mansion Awards*

And here's what's on our to-do list:

- *Attack from Mars: Super Jets*
- *Indiana Jones: The Pinball Adventure: INDY rollover lanes and lane change*
- *Attack from Mars: 5-Way Combo*
- *Red & Ted's RoadShow: Bulldozer hits to ball lock & multiball*
- *Red & Ted's RoadShow: City modes*
- *Centigrade 37: Flip-flopping groups of lit targets*
- *Judge Dredd DeadWorld ball lock and multiball*
- *Demolition Man Crane elevator & unloader*

Recipe: The Addams Family Mansion Awards

This guide shows you how to build an MPF config for *The Addams Family's* Mansion Awards and Tour the Mansion feature. The idea is you can use this as a guide to implement a similar feature in your machine.

Note: This recipe requires MPF 0.33 or newer.

This guide uses the following concepts in MPF that you should be familiar with:

- *Modes*
- *Achievements*
- *Achievement Groups*
- *Shows*

This guide will also show you how to do a few tricky things, including:

- From a group of 12 achievements, ensure that the randomly selected one when the game starts is 1 of 2, not random from all 12.
- Have two shots that light the achievements, but one of the shots lights the achievements indefinitely and the other only lights them for 3 seconds.

You can find the complete runnable machine config for this recipe in the `cookbook/TAF_mansion_awards` folder of the [mpf-examples repository](#) on GitHub.

What are the Mansion Awards & Tour the Mansion?

In The Addams Family, the Mansion Awards are the name for the 12 “goals” which each have a light in the mansion on the playfield just above the flippers.

Tour the Mansion is a wizard mode (associated with the question mark insert at the top of the mansion) that can be started after all 12 mansion awards have been collected.



Here are the specific rules we need to implement:

Mansion Awards

- Lights for incomplete awards are off.
- Complete awards are on solid.
- The currently selected award's light is flashing.
- Hitting any pop bumper will change the currently selected award to another random from the awards that are not yet complete.
- When the game starts, either "Hit Cousin It" or "Mamushka" are selected.
- The selected award is awarded / collected when the electric chair is lit (yellow and red lights on the chair toy) and either the electric chair or swamp shot is hit. (The swamp is technically an operator setting, but we'll use it since that's what the default is.)
- Some of the awards start modes, and others are instant awards with a short show. Collecting an

award immediately turns its light on solid and selects another random uncollected award.

- If 3 Mil is awarded, 6 Mil is spotted (automatically set to complete) as well, and vice-versa. (This differs in the Gold Edition of the game, and is also an operator setting, but we're just going to hard code this behavior for this recipe.)
- The electric chair is lit for 3 seconds after the right inlane is hit.
- The electric chair is lit indefinitely after either ramp is hit.
- The electric chair is lit at the beginning of each ball
- For awards that start modes, the chair can be relit and another award awarded even while the prior award's mode is running.
- Accumulating 15, 25, 35, 45, 55, 65, 75, 85, 95 bear kicks (center ramp) collects the currently selected award (except Tour the Mansion), even if the chair is not lit.
- Each award collected adds 500k to the bonus.

Tour the Mansion

- Once all 12 Mansion Awards have been collected, the Tour the Mansion light (the question mark at the top of the mansion) is selected.
- The electric chair must be lit in the same way as before, and then the shot must be made to the electric chair or the swamp as before.
- This starts the Tour the Mansion mode
- When Tour the Mansion completes, all the mansion awards are reset and a new random one is selected.
- If Tour the Mansion ends before the ball ends, no mansion award can be awarded until the next ball.

Step 1. The machine-wide prerequisites

Before we dig into how to handle the mansion itself, we need to create a machine-wide config that has all the devices we'll need, including the lights for the mansion, switches for the shots we need, the ramps, the right inlane, and the switches, coils, and ball devices we need to glue it all together.

Here's what our machine config looks like. (Note that this is complete in terms of what we need to make this recipe work, but if you have a real Addams Family then you'll probably have a lot more than this in your machine config file.)

```
#config_version=4

modes:
  - mansion_awards
  - chair_lit
  - chair_lit_3s

switches:
  start:
    number: S13
    tags: start
  drain:
    number:
```



```
trough1:
  number: S15
trough2:
  number: S16
trough3:
  number: S17
plunger_lane:
  number: S27
swamp_kickout:
  number: S74
electric_chair:
  number: S43
left_ramp:
  number: S66
center_ramp:
  number: S65
right_inlane:
  number: S25
upper_left_jet:
  number: S31
  tags: jet
upper_right_jet:
  number: S32
  tags: jet
center_left_jet:
  number: S33
  tags: jet
center_right_jet:
  number: S34
  tags: jet
lower_jet:
  number: S35
  tags: jet

virtual_platform_start_active_switches: trough1, trough2, trough3

coils:
  drain:
    number: 05
  trough:
    number: 04
  swamp_kickout:
    number: 08
  electric_chair:
    number: 01

matrix_lights:
  9_mil:
    number: L66
  6_mil:
    number: L54
  3_mil:
    number: L68
  thing:
    number: L51
```



```
quick_multiball:
    number: L55
graveyard_at_max:
    number: L67
raise_the_dead:
    number: L52
festers_tunnel_hunt:
    number: L56
lite_extra_ball:
    number: L53
seance:
    number: L57
hit_cousin_it:
    number: L58
mamushka:
    number: L45
mansion_question:
    number: L65
electric_chair_yellow:
    number: L64
electric_chair_red:
    number: L47

ball_devices:

drain:
    ball_switches: drain
    eject_coil: drain
    eject_targets: trough
    tags: drain

trough:
    ball_switches: trough1, trough2, trough3
    eject_coil: trough
    eject_targets: plunger_lane
    tags: trough, home

plunger_lane:
    ball_switches: plunger_lane
    mechanical_eject: true
    eject_timeouts: 3s
    tags: home, ball_add_live

electric_chair:
    ball_switches: electric_chair
    eject_coil: electric_chair

swamp_kickout:
    ball_switches: swamp_kickout
    eject_coil: swamp_kickout
```


Step 2. Add the achievements

Each mansion award will be an achievement. We decided to create a separate mode called “mansion_awards” just so we can keep everything separate. (This isn’t required, it’s just to help us keep it clear in our minds, and it’s ok to have lots and lots of modes in MPF.)

We’ll configure this mode to start on the *ball_starting* event so it’s always running when a ball is in play. We won’t configure a stop event which means this mode will automatically stop when the ball ends.

Next we add an `achievements:` section and then subsections for our 12 mansion achievements.

You’ll notice that most of them are almost identical. For example, here’s the entry for Thing Multiball:

```
thing_multiball:
  show_tokens:
    lights: thing
  show_when_selected: flash
  show_when_completed: on
  events_when_started: award_thing_multiball # starts thing_multiball mode
  enable_events: initialize_mansion, reset_mansion
  complete_events: award_thing_multiball
  reset_events: reset_mansion
```

Stepping through how we’re using each setting:

show_tokens: link this achievement to it’s light on the playfield.

show_when_selected: flash Plays the show called “flash” when this achievement is selected. Note that the default “flash” show is 1 sec on / 1 sec off. While you can play it faster, the original Addams Family flashed the lights more like .75s on / .25 off, so you’d probably want to create a custom version of the “flash” show for TAF that flashed them more like the original version.

show_when_completed: on Plays the show called “on” when this achievement is complete

events_when_started: award_thing_multiball Posts an event called *award_thing_multiball* when this achievement is started. We’ll use this as the start event for the Thing Multiball mode.

enable_events: initialize_mansion, reset_mansion Enables this achievement when either of the events *initialize_mansion* or *reset_mansion* is posted. Prior to that, this achievement will be disabled.

complete_events: award_thing_multiball Watches for the event *award_thing_multiball*, and when it sees it, it marks this achievement as complete. Notice this is the same event that this achievement posts when it starts. In other words, we’ve configured it so the achievement is complete as soon as it starts! This is by design, because the rules state that once an achievement is awarded, the chair can be relit immediately, and it’s possible to receive the next award even while the mode from the prior award is still running.

reset_events: reset_mansion Watches for an event called *reset_mansion* that will reset this achievement back to its initial (disabled) state.

This achievements configuration takes care of the following rules:

- Lights for incomplete awards are off.
- Complete awards are on solid.
- The currently selected award’s light is flashing.

Step 3. Create an achievement group

Next we need to create an achievement group called “mansion_awards” which will group the 12 mansion achievements together. That will look like this:

```
achievement_groups:
  mansion_awards:
    achievements:
      9_mil
      6_mil
      3_mil
      thing_multiball
      quick_multiball
      graveyard_at_max
      raise_the_dead
      festers_tunnel_hunt
      lite_extra_ball
      seance
      hit_cousin_it
      mamushka
    show_tokens:
      lights: electric_chair_yellow, electric_chair_red
    auto_select: yes
    events_when_all_completed: select_tour_mansion
    enable_while_no_achievement_started: no
    show_when_enabled: on
    select_random_achievement_events: sw_jet
    allow_selection_change_while_disabled: yes
    disable_while_achievement_started: no
    start_selected_events: balldevice_electric_chair_ball_enter, balldevice_swamp_kickout_ball_enter,
    ↪award_mansion_from_bear
    enable_events: light_chair
    disable_events: unlight_chair
```

Let’s look at each of these settings:

achievements: This is just the list of the 12 achievements that make up this group.

show_tokens: These are the show tokens for the group itself. In this case they’re the two lights on the electric chair, since those lights turn on and off to indicate whether the chair or swamp can be shot to award the currently selected item.

auto_select: yes This is used to make sure that one achievement is selected at all times. If the currently selected achievement is completed, the achievement group will notice that there is no currently selected achievement and it will pick one from random from the remaining achievements (those that are “enabled”).

events_when_all_completed: select_tour_mansion Posts an event called *select_tour_mansion* once all 12 achievements in this group in complete. We’ll use this later to light the “tour mansion” award.

enable_while_no_achievement_started: no In our case, we do not want to automatically enable the achievement group when no achievement is started, because the rules for Addams Family say that the player has to shoot the center ramp or right inlane to light the chair (which is enabling this achievement group).

show_when_enabled: on This plays the show called “on” when the achievement group is in the enabled state. This will have the effect of turning on the red and yellow chair lights (from the

`show_tokens`: section) when the achievement group is enabled and the selected item can be awarded.

select_random_achievement_events: `sw_jet` In Addams Family, each pop bumper hit changes the currently selected mansion award. To make this happen, we added a tag called “jet” to the five pop bumper switches. (That will post an event called `sw_jet` any time one of these switches is hit. Then we add that event name here which will cause this achievement group to change the currently selected award.

allow_selection_change_while_disabled: `yes` The pop bumper hits to change the current selection happens regardless of whether the group is enabled (e.g. the chair is lit) or not, so we use this setting to allow that selection change to happen at any time.

start_selected_events: `balldevice_electric_chair_ball_enter, balldevice_swamp_kickout_ball_enter, award_mans`
A shot to either the electric chair or the swamp kickout will award the selected achievement.

enable_events: `light_chair` When an event called `light_chair` is posted, this achievement group will be enabled (which will turn on the chair lights and allow the selected achievement to be started via the `start_selected_events`:).

disable_events: `unlight_chair` When an event called `light_chair` is posted, this achievement group will be disabled. The chair lights will turn off, and the `start_selected_events`: will not cause the current selected achievement to start.

This step takes care of:

- Hitting any pop bumper will change the currently selected award to another random from the awards that are not yet complete.
- The selected award is awarded / collected when the electric chair is lit (yellow and red lights on the chair toy) and either the electric chair or swamp shot is hit.

Step 4. Light the electric chair

Now that we have the basic achievements and achievement group structure laid out, let’s focus on getting the chair lit. We’ll look at the following four rules:

- The electric chair is lit for 3 seconds after the right inlane is hit.
- The electric chair is lit indefinitely after either ramp is hit.
- The electric chair is lit at the beginning of each ball
- For awards that start modes, the chair can be relit and another award awarded even while the prior award’s mode is running.

At first this seems pretty straightforward. If the center ramp is shot, post an event to enable the achievement group. If the right inlane is hit, post an event to enable the achievement group and also set a timer that will disable it 3 seconds later. The problem with this is that if the chair was previously lit from the ramp when the inlane is hit, we don’t want the inlane timer to disable the chair after 3 seconds.

There are several ways in MPF to achieve this. In our case, we’re going to use modes. (We really like [using modes for game logic](#).)

The two modes we’re going to create are:

- `chair_lit_3s`
- `chair_lit`

The `chair_lit_3s` mode

Let's look at the config for the “`chair_lit_3s`” mode:

```
#config_version=4

mode:
  priority: 101
  start_events: right_inlane_active
  stop_events:
    unlight_chair
    balldevice_electric_chair_ball_enter
    balldevice_swamp_kickout_ball_enter
    cancel_chair_timer

event_player:
  mode_chair_lit_3s_started: light_chair
  timer_unlight_chair_complete: unlight_chair

timers:
  unlight_chair:
    end_value: 3
    start_running: yes
```

Notice that this mode started when the *right_inlane_active* switch is hit, which means it starts when the right inlane is hit. Pretty simple.

When it comes to stop events, we have four of them. First is *unlight_chair*. This mode has a timer (for 3 seconds) which starts when the mode starts, so when that completes, it posts *timer_unlight_chair_complete* which the event player uses to post *unlight_chair* which will stop the mode. (The *unlight_chair* event is also used by the mansion achievement group to disable itself.

There are also stop events for *balldevice_electric_chair_ball_enter* and *balldevice_swamp_kickout_ball_enter* which stop this mode if either of those shots are hit. Notice those are also *start_selected_events*: for the achievement group, so hitting either one of those will start the selected achievement (if the group is enabled) and also stop this mode.

You may be wondering why we have both of those ball enter events listed here? Why not just use an “*events_when_started*” setting in the achievement group to stop this mode? The reason is for this rule here:

- Accumulating 15, 25, 35, 45, 55, 65, 75, 85, 95 bear kicks (center ramp) collects the currently selected award (except Tour the Mansion), even if the chair is not lit.

This shot will “start” an award, but if the chair is lit, we do not want it to unlight, so that’s why we need to stop the `chair_lit_3s` mode based on the actual chair or swamp being hit, not just any time the selected award is started.

Finally, notice there’s also an event called *cancel_chair_timer* which will stop this mode. We’ll talk about that in a bit.

The only other thing to discuss in this mode is the *event_player*:. We talked about the timer being used to post the *unlight_chair* event. But notice there’s also an entry *mode_chair_lit_3s_started*: *light_chair* which posts the *light_chair* event when the mode starts. (This event is listed in the achievement group as the event which enables it.) These settings, in combination, mean that when the `chair_lit_3s` mode is running, the mansion achievement group will be enabled (e.g. the chair is lit).

The chair_lit mode

The second mode we're going to create will be like the `chair_lit_3s` mode, except instead of having a timer that stops the mode after 3 seconds, this mode will stay active until the chair or swamp is hit. (Well, or until the ball ends, as by default, all modes end when the ball ends automatically.)

Here's the config for this mode:

```
#config_version=4

mode:
  priority: 102
  start_events: center_ramp_active, ball_starting
  stop_events:
    balldevice_electric_chair_ball_enter
    balldevice_swamp_kickout_ball_enter

event_player:
  mode_chair_lit_stopping: unlight_chair
  mode_chair_lit_started: light_chair, cancel_chair_timer
  mode_chair_lit_3s_started: cancel_chair_timer

logic_blocks:
  counters:
    initialize_mansion:
      count_events: mode_chair_lit_started
      events_when_complete: initialize_mansion
      count_complete_value: 1
      persist_state: true
```

The `start_events`: are pretty straightforward. We start the mode when the center ramp is hit, and also on `ball_starting` since the Addams Family rules state that the chair is lit at the beginning of every ball.

This mode has an `event_player` to help with the logic. When this mode stops, we also post the `unlight_chair` event which is one of the disable events for the mansion achievement group. We also post the `light_chair` event when the mode starts to enable the group.

The final two event player settings help us with the interaction between this mode and the 3 second timed version. We have `cancel_chair_timer` as an event that's fired when this mode starts too. Notice that that event is one of the `stop_events` for the other mode. The reason for this is that if the ball hits the right inline and the chair is lit for 3 seconds, and then the ball hits the center ramp within those 3 seconds, we need to make sure the chair stays lit indefinitely, meaning we need to stop the 3s mode so it doesn't shut the chair off. So that's what this event is doing.

Similarly if the player had previously hit the center ramp (which starts this mode to light the chair), and then the player hits the right inline, we also need to kill that 3s mode to make sure it doesn't turn off the chair, so we do that with the event player setting `mode_chair_lit_3s_started: cancel_chair_timer`. Basically this setting means that if this mode sees the 3s mode, it shuts it down. :) And obviously this shut down only happens if this mode is running.

What about that logic block? Let's discuss that in the next step...

Step 5. Select the proper award at game start

One of the twists of the Addams Family mansion awards is that when the game first starts, it always starts with either “Hit Cousin It” or “Mamushka” selected. So we have to figure out a way to randomly pick from one of those two (instead of all 12) at the start of the game, but then every random choice after that has to be from all 12 (well, of the ones that have not yet been awarded out of all 12).

We’ll tackle this in two parts.

First, take a look at the Hit Cousin It and Mamushka achievements:

```
hit_cousin_it:
  show_tokens:
    lights: hit_cousin_it
  show_when_selected: flash
  show_when_completed: on
  events_when_started: award_hit_cousin_it # starts hit_cousin_it mode
  complete_events: award_hit_cousin_it
  reset_events: reset_mansion

mamushka:
  show_tokens:
    lights: mamushka
  show_when_selected: flash
  show_when_completed: on
  events_when_started: award_mamushka # starts mamushka mode
  complete_events: award_mamushka
  reset_events: reset_mansion
```

Notice that they’re slightly different than the other 10 mansion awards in that they do NOT have enable events.

The reason for this is that devices in MPF that have enable events in their configurations are NOT automatically enabled when they’re created. (This is because MPF thinks, “Hey, you have enable events, so you have some way to enable them, so you can enable them whenever you want.” But if there are no enable events, like these two, then MPF will enable them immediately.)

This means that when this mode first starts and these 12 mansion achievements are created, the hit_cousin_it and mamushka achievements are enabled immediately (since they don’t have enable events), and the other 10 mansion awards are disabled (since they do have enable events). Since the achievement group is configured for auto_select: yes, it will automatically (and immediately) pick one of the enabled achievements which will change into the selected state (and start its select show, etc.). This means that the initial selection will always be one of those two.

However, once the initial selection is made, we need a way to enable the remaining 10 mansion awards. For this we’ll use a counter logic block:

```
# This is in the chair_lit mode config, NOT machine-wide config

logic_blocks:
  counters:
    initialize_mansion:
      count_events: mode_chair_lit_started
      events_when_complete: initialize_mansion
      count_complete_value: 1
      persist_state: true
```


This is a simple counter that “counts” the *mode_chair_lit_started* event (which is posted by this mode once it’s fully started and done initializing). The count complete value is one, meaning that once it sees this event once, it’s done. We tell it to persist its state so that it remembers where it was from ball-to-ball (meaning it will only run once ever in the game) and when it’s done (which is after it sees that event once) it will post the event *initialize_mansion*.

(Remember that logic block states are stored on a per-player basis, so everything we say happens “once” here is really “once per player”.)

Note also that in the 10 “other” mansion achievements, we have *initialize_mansion* listed as one of their enable events. This means that when this counter completes its count (of 1) that it will post that event which will enable the other 10 achievements.

At this point you’ll have 1 achievement selected (which will be either Hit Cousin It or Mamushka), and you’ll have the other 11 in the “enabled” state.

Hitting a pop bumper will pick a new random selected achievement.

Step 6. Kick off the award

Next up we have an easy thing: Starting the modes and/or kicking off the shows for each mansion award.

In this case, note that our 12 mansion achievements each have an *events_when_started*: setting with a unique event name, like *award_seance* or *award_lite_extra_ball*. So just use that event to either start a mode or to play a show. Simple!

- Some of the awards start modes, and others are instant awards with a short show. Collecting an award immediately turns its light on solid and selects another random uncollected award.

Step 7. Collect the selected award via the bear kick

Todo: Need to explain this fully

- Accumulating 15, 25, 35, 45, 55, 65, 75, 85, 95 bear kicks (center ramp) collects the currently selected award (except Tour the Mansion), even if the chair is not lit.

Step 8. Setup the 3 Mil / 6 Mil linking

- If 3 Mil is awarded, 6 Mil is spotted (automatically set to complete) as well, and vice-versa.

This is pretty simple. Just add the events posted when one achievement is started to the complete events for the other. Here are the examples:

```
6_mil:
  show_tokens:
    lights: 6_mil
  show_when_selected: flash
  show_when_completed: on
  events_when_started: award_6_mil # instant points award & plays shows, also spots 3 mil
  enable_events: initialize_mansion, reset_mansion
  complete_events: award_6_mil, award_3_mil
```



```
reset_events: reset_mansion

3_mil:
  show_tokens:
    lights: 3_mil
  show_when_selected: flash
  show_when_completed: on
  events_when_started: award_3_mil # instant points award & plays shows, also spots 6 mil
  enable_events: initialize_mansion, reset_mansion
  complete_events: award_3_mil, award_6_mil
  reset_events: reset_mansion
```

Notice that the 6_mil's complete_events: includes *award_3_mil* and vice-versa.

Step 8. Add 500k to the bonus for each award collected

Todo: Need to explain this fully

- Each award collected adds 500k to the bonus.

Step 9. Move on to Tour the Mansion after all 12 awards have been completed

Todo: Need to explain this fully

- Once all 12 Mansion Awards have been collected, the Tour the Mansion light (the question mark at the top of the mansion) is selected.
- The electric chair must be lit in the same way as before, and then the shot must be made to the electric chair or the swamp as before.
- This starts the Tour the Mansion mode

Step 10. Reset everything when Tour the Mansion is complete

Todo: Need to explain this fully

- When Tour the Mansion completes, all the mansion awards are reset and a new random one is selected.
- If Tour the Mansion ends before the ball ends, no mansion award can be awarded until the next ball.

Config file reference

This section contains details about every possible entry you can use in your YAML config files. Each entry also has information about whether it's valid in your machine-wide config, a mode-specific config, or both.

Instructions

As you dig into the specific settings for individual config sections, it's important to understand how various settings mentioned in the reference are used:

Config file instructions

TODO

Understanding the `#config_version` setting

Since MPF is mainly “programmed” with YAML-based config files, we need a way for MPF to know that the config file(s) it's loading are compatible with the version of MPF that's running.

This is specified in the very first line of a config file (in both the machine-wide configs and mode config files). You specify the config version with a list that starts with a hash sign, like this:

```
#config_version=4
```

In YAML, lines that start with `#` are ignored, which means the YAML processor skips this line, but MPF uses it to make sure the config file it's trying to load will work with that version of MPF.

Not every new version of MPF changes the `config_version` number. If we release a new version of MPF that does not have a new `config_version` number, then you can use the new version of MPF without needing to make any changes to your config files.

Updating your config files to the latest version

MPF includes a config file migration tool that can automatically migrate your config files to the latest version.

Which versions of MPF require which config_versions?

- MPF 0.30+: #config_version=4
- MPF 0.20-0.21: #config_version=3
- MPF 0.19: #config_version=2
- MPF 0.17-0.18: #config_version=1
- MPF 0.1-0.16: config_version not used (a.k.a. config version 0)

Machine config files

TODO

Mode config files

TODO

Using dynamic runtime values in config files

MPF config files can contain values in the form of links to dynamic placeholders which are evaluated live when MPF is running rather than being hard-coded into a config file.

Dynamic values can come from several sources, including player variables, machine variables, operator settings, properties of devices, etc. (Read on for a full list.)

For example, you might want to have a shot called “jackpot” that scores a multiplier which is the number of shots made times 100k points.

Without dynamic values, your scoring section would be static, like this:

```
scoring:
  shot_jackpot_hit:
    score: 100000
```

But let’s say you have a player variable called “troll_hits” which holds the number of trolls hit that you want to multiply by 100,000 when the shot is made. You can use the “current_player” dynamic value in your scoring config like this:

```
scoring:
  shot_jackpot_hit:
    score: current_player.troll_hits * 100000
```

Another example might be operator settings. Rather than hard coding tilt warnings to 3, you might want to like the operator choose the tilt warnings.

So instead of this:


```
tilt:
  warnings_to_tilt: 3
```

You would have this instead:

```
tilt:
  warnings_to_tilt: settings.tilt_warnings
```

(Note the example above requires that you have a `settings:` section in your machine config and that you've defined a setting called "tilt_warnings").

You can also use dynamic values in *conditional events*.

Types of dynamic values

current_player Used to get a player variable from the current player. The format is `current_player.variable_name`, for example `current_player.ball`. A list of player variables is [here](#).

players `players[0].variable_name`

game `game.tilted` `game.slam_tilted` `game.num_players` `game.balls_in_play`

machine

`machine.game`

settings

`todo`

device

`todo`

Using if/else logic with dynamic values

```
logic_blocks:
  counters:
    my_counter:
      count_complete_value: 5 if player.wizard_complete else 3
```

Full Python code

TODO (The format below probably doesn't work and needs to be tested)

logic_blocks:

counters:

my_counter:

count_complete_value: |

if self.machine.game.player: return 1

else: return 5

Gamma correction in MPF

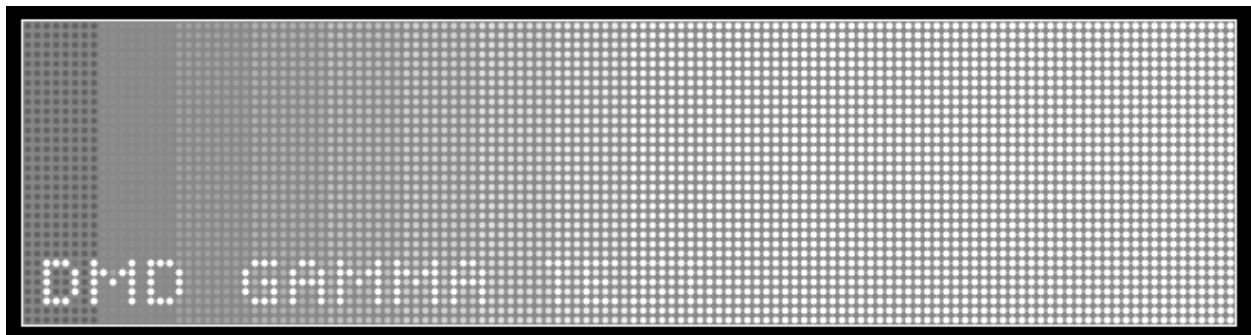
MPF includes functionality to allow you to adjust the gamma of the color information that is sent to physical DMDs (RGB and mono) and to RGB LEDs. (You don't need to set the gamma of an LCD display since that's handled by your OS.)

You can read full details in the [Gamma correction](#) article on Wikipedia, but the quick explanation is that the human eye doesn't not perceive a change in brightness at the same ratio that an LED sets its brightness.

When you're setting colors in MPF, you expect that 100% brightness looks fully bright, and that 50% looks like 50%, etc. Here is a screenshot of a slide which has 16 bars which fade from off to fully white, in a more-or-less even fashion:



However if you show this slide on your physical DMD with no gamma correction, it looks something like this:



Even though the individual pixels are showing their "correct" brightness, the human eye can't really tell a different between 50% and 100%, and pretty much everything on the right half of the DMD looks fully white.

So you can adjust this by setting the gamma value. By default, MPF uses a gamma value of 2.5 for RGB LEDs, and 2.2 for RGB DMDs. (It also uses a value of 1.0 for mono DMDs since some of the hardware controllers do their own internal gamma correction, though others don't, so you might have to change them.

We recommend you read the documentation for the [physical_dmds:](#), [physical_rgb_dmds:](#), and [color_correction_profiles:](#) (for LEDs) to set the proper gamma.

Tuning your DMD gamma

MPF includes a built-in gamma test slide (the one used in the images above) which you can use to dial-in your gamma setting.

The easiest way to show this slide on your physical DMD is to make a temporary addition to your machine config to add a slide player, like this:

```
slide_player:
  mode_attract_started:
    dmd_gamma_test:
      priority: 10000000
```

This will just show the gamma test slide at a crazy high priority so it shows on top of everything else. (Remember if your DMD is not your default display, you'll also have to add `target: dmd` or whatever you use to target slides to your DMD.)

Now you can play with different gamma settings for your DMD in either your `physical_dmds:` or `physical_rgb_dmds:` section. (Note you'll have to restart MPF after each change you make.)

Note that you might also have to adjust `brightness:` along with `gamma:`. For example, some people had to set the brightness of their RGB DMDs to a super low value, like 0.1 or 0.2 before MPF had gamma control, but with proper gamma settings, you can probably take your brightness up to somewhere around 0.5.

We like to use the gamma test slide and set the brightness first based on the right-most brightest block, and then once that's set, we start messing with the gamma. It will probably be some trial-and-error, but once it's dialed in it's a "set it and forget it" type of thing.

How to enter gain values in config files

The sound-related items in your config files contain various volume settings that may be specified as a gain value. MPF gives you the flexibility to specify gain values as simple numeric values between 0.0 and 1.0 or as a decibel string between -inf and 0.0 db. Individuals with audio or video editing experience may be more comfortable working with decibel values.

Entering a simple numeric gain value

To enter a simple numeric gain value, simply enter a number between 0.0 and 1.0 with no appended label string. Some examples:

```
master_volume: 0.5

volume: 0.1334

volume: 1.0

volume: 0.0
```


Entering a gain value in decibels

To enter a gain value in decibels, enter your value between -inf and 0.0 and add a “db” after your value. (This can be uppercase or lowercase, and you can put a space in between your value and the letters if you want.)

Note: -inf indicates the minimum gain value (equivalent to 0.0 in a simple numeric gain value) and should not contain a “db” suffix. For all other decibel values if you do not enter the “db” suffix after your value, then MPF will read in the gain value as a simple numeric gain value between 0.0 and 1.0.

Some examples:

```
master_volume: -6.0db  
  
volume: -17.5db  
  
volume: 0.0 db  
  
volume: -inf
```

It makes no difference whether you enter your gain values in simple numeric format or decibels, as MPF will convert everything to simple gain values under-the-hood when it reads in your configuration files.

How to enter time strings in config files

Your machine configuration files are full of settings which require time values to be entered, such as “10 seconds” or “250 milliseconds.”

Rather than arbitrarily decide which values should be entered as seconds versus milliseconds, we’ve built MPF so that you can enter either one whenever a time entry is needed which MPF will internally convert to the proper value.

These time values are used all over the place. (Ball device count delays, ball save time, ball search settings, reset delays, slide expiration times, etc.)

We’ll use an example from a ball device for the `ball_count_delay`: setting. (Again, this is just an example. You use these same options whenever you need to enter a time value):

Entering a time duration in seconds

To enter a time duration in seconds, simply add an “s” or “sec” after your number. (This can be uppercase or lowercase and you can put a space in between your number and the letters if you want.)
Some examples:

```
ball_count_delay: 0.5s  
  
ball_count_delay: 0.5 S  
  
ball_count_delay: 0.5sec
```


Entering a time duration in milliseconds

To enter a time duration in seconds, simply add an “ms” or “msec” after your number. (This can be uppercase or lowercase, and you can put a space in between your number and the letters if you want.)

Note that if you do not enter and letters, then MPF will read in the time duration in whatever the default scale is for that particular setting. (The instructions for each setting should say whether the default is seconds or ms.

Some examples:

```
ball_count_delay: 500ms
ball_count_delay: 500 MS
ball_count_delay: 500msec
ball_count_delay: 500
```

It makes no difference whether you enter your time durations as seconds or milliseconds, as MPF will convert everything to milliseconds (since that’s the default for *ball_count_delay* when it reads in your configuration files.

Entering a time duration in minutes, hours, or days

You can also enter time strings in MPF for time periods longer than seconds or milliseconds. While this isn’t practical for things like ball device delays, it’s used in certain modules (like the credits module) for some settings.

Some examples:

```
credit_expiration_time: 2m      # 2 minutes
credit_expiration_time: 2h      # 2 hours
credit_expiration_time: 2d      # 2 days
```

Case insensitivity in config files

Setting names config files are not case sensitive. This was done to prevent confusion as people would typically miss case settings. For example, in MPF prior to version 0.17, the following would work:

```
SlidePlayer:
```

While the following would not:

```
Slideplayer:
```

What happens internally is that all the settings (i.e. the “keys” of the key/value pairs in config files) are converted to lowercase internally. We believe that this should not be a problem and in fact should be transparent to most game programmers. We also have attempted to make sure that all functions that reference objects that are set up in the config files also convert their references to lower case. For example, if you have a coil defined like this:


```
coils:
  flipperLeftMain:
    number: ...
```

And then later you refer to it via your code as

```
self.machine.coils['flipperLeftMain']
```

That will still work because the device collection object that holds the list of coils will convert the incoming request to lowercase. All that said, there's one "gotcha" with this. The case insensitivity means that you cannot differentiate between devices bases solely on case differences. For example, in versions of MPF prior to 0.17, it was perfectly valid to define lane lights based on uppercase letters. For example, the three lights that make up "W", "I", and "N" lanes could have been defined as `lane_wIn`, `lane_wIn`, and `lane_wiN` previously. Starting with MPF 0.17, you'll have to differentiate them in some other way. (For example, `lane_win_w`, `lane_win_i`, and `lane_win_n`. We believe this change was for the better, but we're always open to options. If you believe we should change this behavior, please start a discussion in our MPF Development forum.

Device Control Events

Many devices in MPF have configuration options which lets them be controlled via events. (These are called "device control events".) For example, flippers and autofire coils have *enable_events* and *disable_events*, shots have *enable_events*, *disable_events*, and *reset_events*, shot groups have *enable_events*, *disable_events*, *reset_events*, *rotate_right_events*, and *rotate_left_events*, etc.

You can specify these events in each device's settings on a machine- wide basis in your machine config, and you can also specify these events that are only active when a mode is active in your mode config files. There are several options for how you specify these device control events, depending on what you want to do.

If you have just one event

Even though these configuration entries use the word "events" (plural), you can configure them for just one event. For example, if you have a flipper device that you want to enable when a ball starts, you can add the following line to the configuration for your flipper:

```
enable_events: ball_started
```

If you have multiple events

If you want one of these actions to be performed based on any one of multiple events, you can enter multiple events. For example, maybe you want to disable a flipper when the ball ends, but you also want to make sure it's disabled when a tilt or slam tilt event is posted. In that case you'd enter your configuration like this:

```
disable_events: ball_ending, tilt, slam_tilt
```

Note that in this case, the flipper will disable if *any* of these events is posted. If you want to get fancy and require that multiple events need to be posted before you disable your flipper, then you would use an Accrual or Sequence Logic Block to track those events, and then you'd add a new event to your

events_when_complete: in that Logic Block and then enter that same event in the disable_events: for your flipper.

Note that when you're entering multiple events, you can enter them all on the same line separated by commas, or you can enter each one on its own line started with a dash and a space, like this:

```
disable_events:
- ball_ending
- tilt
- slam_tilt
```

It makes no difference to MPF, rather this is just a personal preference for how you want your config files to look.

If you want to configure “delays” before performing your action

You can also enter delays (in either seconds or milliseconds) which cause the enable, disable, or reset events to wait after one of your events is fired. Here's an example from the “Solids” drop target bank in Big Shot:

```
reset_events:
    ball_starting: 0
    collect_special: .75s
```

In this case when the *ball_starting* event is posted, MPF will reset the drop target group immediately (no delay, due to the “0” value), and when the *collect_special* event is posted, MPF will wait 0.75 seconds before resetting it. (So you see that different events can have different delays.) In case you're wondering why we did this, take a look at the reset_events configuration for the other bank of drop targets (called “Stripes”) in Big Shot:

```
reset_events:
    ball_starting: 0.25s
    collect_special: 1s
```

If you look at these two sets of configurations together, you see that when the *ball_starting* event is posted, MPF will reset the Solids drop target bank immediately and then wait a quarter of a second before resetting the Stripes drop target bank. We did this so that the reset emulates the original characteristics of resetting one then the other in succession, rather than resetting them both at the same time.

Also note that we have a similar quarter-second delay between the two drop target banks when we reset them after the special is collected, but in this case we reset them after 0.75 and 1 second. That's because that collecting the special awards a replay which fires the knocker, but if the knocker fires at the same time as the drop targets are reset then the player can't hear the knocker since the drop target reset coils in Big Shot are so massive. So when the special is collected, we fire the knocker immediate, then 0.75 seconds later we reset the Solids drop target bank, then 0.25 seconds after that we reset the Stripes drop target bank.

You can enter these delay times in either seconds or milliseconds, as outlined [here](#). All this is done via the config files with no custom Python code needed! :)

Overwriting config files

todo

Specifying Colors in Config Files

Colors in config files can be specified by name (like “red”) or by hex value (“ff0000”).

You can see a list of valid color names (and their respective colors) [here](#).

In addition to the 140 standard named colors, MPF adds the following color options:

- off - maps (0,0,0) which is more intuitive than “black” when you’re working with LEDs.
- on - turns on an LED with that LED’s default_color: setting. (Default is “white” if you don’t specify a color.)

You can also specify color by hex string. If you do this, do *NOT* put a # in it, since YAML files use those for comments which are ignored.

- CORRECT: color: ff0000
- WRONG: color: #ff0000

Specifying opacity / alpha

For colors which will be processed by the media controller (such as slide background and widget colors), you can optionally add two more characters to a hex color to specify the alpha value.

For example:

- ff0000ff (fully opaque)
- ff000080 (50% opacity)

See the [Widget Opacity & Transparency](#) documentation for details.

Understanding tags

Todo: Need to add this

Understanding the debug: setting

Todo: Need to add this

```
mpf:
  debug_log:
    - clock
```


Entry	Module it debugs
clock	Scheduled tasks & callbacks
modes	Mode controller (starting and stopping modes)

Config player “express” configs

Todo: Need to add this

How to add lists to config files

Throughout the Mission Pinball Framework config files, there are several places where the configuration items need to be a “list” or a “list of lists.” The MPF config files are in a YAML format, so you add list items by following the YAML spec, but it can be a kind of confusing. So this page is our “how to” guide for the various ways you can add list items to MPF config files. First of all, there are several different places we need lists. For example, device tags, logic block events, switches that make up shots, etc. For our explanation, we’ll use a generic list item with generic configurations. Some examples:

```
flipperLeft:
  number: SD18
  tags: flipper, player # this is a list
```

```
Shots:
  outlane:
    Switch: leftOutlane, rightOutlane #this is a list
```

```
Auditor:
  save_events: # This config wants a list
    game_started # This is the first list item
    ball_ended # This is the second list item
    game_ended # This is the third list item
```

```
light_special:
  events:
    - sw_eightball # this is the first list item
    - drop_targets_Solids_lit_complete, drop_targets_Stripes_lit_complete # 2nd list item, which
↳ itself has two items
```

Valid options for lists

Ok, so let’s say you have a config item that needs a list. We’ll use a made-up config called “config” with three list items: item1, item2, and item3. You can enter this into your config file in one of several ways. First, you can enter all the items on one line separated by commas:

```
config: item1, item2, item3
```


Second, you can enter all the items on one line separated by spaces: (Obviously you can't do this if your individual items have spaces in their names. In that case, just use commas.)

```
config: item1 item2 item3
```

Third, you can enter each item on its own line, like this: (Be sure that you indent your list items, and that they are all indented the same amount.)

```
config:
  item1
  item2
  item3
```

Fourth, you can enter each item on its own line, indented, with each line starting with a dash, like this: (Be sure to include the space after the dash before the list item. It's a YAML thing.)

```
config:
  - item1
  - item2
  - item3
```

So you have four options. Which one should you pick? It really doesn't matter. You can use whichever one has the style you prefer and whichever one makes your config files easiest to read. (We tend to just use commas, but if it's a long list then we'll put each item on its own line so the line doesn't wrap.)

Valid options for "lists of lists"

Some config items require "lists of lists" where there is a list with multiple items, and then each of those items is itself another list which may have multiple items. (This is seen a lot in MPF's Logic Blocks where we have multiple steps that can each be made up of one or more events.) The easiest way to enter these into your configuration files is to combine the method using commas and dashes, like this:

```
config:
  - item1, item2
  - item3, item4, item5
  - item6
```

So in the example above, the configuration item has a list with three items. The first list item contains item1 and item 2, the second list item contains item3, item4, and item5, and the third list item contains item6. You can also enter each item on it's own line and then use dashes to signify where a new list item starts, like this:

```
config:
  - item1
    item2
  - item3
    item4
    item5
  - item6
```

Note that the indentation of all your items is the same, but that the dash is "outdented".

How to create and understand YAML files

Indentation

any number is fine

2, 4, 3, 17, whatever

only key is that things at the same level are indented all the same

any increase in indent indicates that line is a subsection of the line above it

Dashes

Colons

Quotes

Index of config sections

Here's a list of every single config section from both MPF and the MPF-MC. Some of these are valid only in machine-wide configs, and others only work in mode config files. (And some are valid in both.) The detail page for each setting indicated which type of config file it's valid in.

accelerometers:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The accelerometers: section of your config is where you configure accelerometers, including how many G forces trigger different events.

Like other hardware devices, you create a sub-entry for each accelerometer, then under there you configure additional settings. For example:

```
accelerometers:
  test_accelerometer:
    number: 1
    level_x: 0
    level_y: 0
    level_z: 1
    hit_limits:
      0.5: event_hit1
      1.5: event_hit2
    level_limits:
      2: event_level1
      5: event_level2
```


Settings:**debug:**

Single value, type: boolean (Yes/No or True/False). Default: False

Enables additional debug logging for this device.

hit_limits:

One or more sub-entries, each in the format of type: float:str. Default: None

Todo: Add description.

label:

Single value, type: string. Default: %

Friendly name for this device.

level_limits:

One or more sub-entries, each in the format of type: float:str. Default: None

Todo: Add description.

level_x:

Single value, type: integer. Default: 0

Todo: Add description.

level_y:

Single value, type: integer. Default: 0

Todo: Add description.

level_z:

Single value, type: integer. Default: 1

Todo: Add description.

number:

Single value, type: string.

The platform-specific hardware number of this accelerometer.

platform:

Single value, type: string. Default: None

Name of the platform this accelerometer is connected to. The default value of None means the default hardware platform will be used. You only need to change this if you have multiple different hardware platforms in use and this coil is not connected to the default platform.

See the [Mixing-and-Matching hardware platforms](#) guide for details.

tags:

List of one (or more) values, each is a type: string. Default: None

Note there are no “special” tags for accelerometers.

achievements:

Config file section

Changed in version 0.32.

Valid in machine config files	NO
Valid in mode config files	YES

The achievements: section of your config is where you configure [player-based “achievement” tracking](#).

Like most things in MPF configs, the highest-level entries in the achievements: section of your config are the names of the individual achievements, and then indented under each of those are the settings for that individual achievement.

Here’s an example achievements section from Brooks & Dunn:

```
achievements:
  world_tour:
    show_tokens:
      leds: 1_world_tour
    show_when_selected: flash
```



```
show_when_started: flash
show_when_completed: on
events_when_started: start_world_tour_mode
restart_after_stop_possible: true
events_when_completed: rotate_mission_rotator, light_mission_select
complete_events: world_tour_success
enable_events: world_tour_fail, ball_will_end

money_bags:
  show_tokens:
    leds: 1_money_bags
  show_when_selected: flash
  show_when_started: flash
  show_when_completed: on
  events_when_started: start_money_bags_mode
  restart_after_stop_possible: true
  events_when_completed: rotate_mission_rotator, light_mission_select
  complete_events: money_bags_success
  enable_events: money_bags_fail, ball_will_end

music_awards:
  show_tokens:
    leds: 1_music_awards
  show_when_selected: flash
  show_when_started: flash
  show_when_completed: on
  events_when_started: start_music_awards_mode
  restart_after_stop_possible: true
  complete_events: music_awards_success
  events_when_completed: rotate_mission_rotator, light_mission_select
  enable_events: music_awards_fail, ball_will_end

jukebox:
  show_tokens:
    leds: 1_jukebox_insert
  show_when_selected: flash
  show_when_started: flash
  show_when_completed: on
  events_when_started: start_jukebox_mode
  restart_after_stop_possible: true
  events_when_completed: rotate_mission_rotator, light_mission_select
  complete_events: jukebox_success
  enable_events: jukebox_fail, ball_will_end

play_poker:
  show_tokens:
    leds: 1_play_poker
  show_when_selected: flash
  show_when_started: flash
  show_when_completed: on
  events_when_started: start_play_poker_mode
  restart_after_stop_possible: true
  events_when_completed: rotate_mission_rotator, light_mission_select
  complete_events: play_poker_success
  enable_events: play_poker_fail, ball_will_end
```


More examples:

- *Recipe: The Addams Family Mansion Awards*
- *achievement (example config files)*

General Settings

The following settings are used to configure each achievement. Since achievements are so flexible, these are all optional, though you need to use some of them or your achievement won't do anything. :)

show_tokens:

One or more sub-entries, each in the format of type: str:str. Default: None

This is an indented list of key/value pairs for the *show tokens* that will be sent to the shows that are played when this achievement changes state. (See the settings called "show_when_XXX" further down in this documentation.)

start_enabled:

Deprecated since version 0.33.

This setting has been removed since it was unlike every other device in MPF. Achievements now use `enable_events`: to indicate initial state. If there are no enable events, the achievement will start enabled. If there are enable events, the achievement will start disabled since it's presumed that one of the start events will be used to enable it later.

restart_after_stop_possible:

Single value, type: boolean (Yes/No or True/False). Default: True

Is it possible to restart this achievement after it's been stopped?

restart_on_next_ball_when_started:

Single value, type: boolean (Yes/No or True/False). Default: True

If True/Yes, then this achievement is set to the "started" state when the player's next ball starts if it was in the "started" state when the previous ball ended. This is useful if you want to restart a mode that was running when the ball ended.

Note that this restart will also play the `show_when_started`: show, and it will also post the `events_when_started`: events.

enable_on_next_ball_when_enabled:

Single value, type: boolean (Yes/No or True/False). Default: True

If a ball ends when this achievement is enabled, should it automatically enable itself again when the next ball starts? This is similar to the `restart_on_next_ball_when_started:` event from above, except it applies to the “enabled” state instead of the “started” state.

This setting will also play the `show_when_enabled:` show, and it will also post the `events_when_enabled:` events.

debug:

Single value, type: boolean (Yes/No or True/False). Default: False

Enables debug logging.

Control Events

The following settings specify which MPF events cause this achievement to move to a new state.

enable_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, cause this achievement to switch to its “enabled” state. These events will also cause the achievement to play the show defined in the `show_when_enabled:` setting and to emit (post) events in the `events_when_enabled:` setting.

select_events:

New in version 0.32.

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, cause this achievement to switch to its “selected” state. These events will also cause the achievement to play the show defined in the `show_when_selected:` setting and to emit (post) events in the `events_when_selected:` setting.

Note that the “selected” state, in MPF, is used to describe an achievement that is currently selected (“highlighted” or “lit”) and available to be started. This would typically be tied to a show (via the `show_when_selected:` setting) that causes a light or LED to flash.

start_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, cause this achievement to switch to its “started” state. These events will also cause the achievement to play the show defined in the `show_when_started`: setting and to emit (post) events in the `events_when_started`: setting.

complete_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, cause this achievement to switch to its “completed” state. These events will also cause the achievement to play the show defined in the `show_when_completed`: setting and to emit (post) events in the `events_when_completed`: setting.

disable_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, cause this achievement to switch to its “disabled” state. These events will also cause the achievement to play the show defined in the `show_when_disabled`: setting and to emit (post) events in the `events_when_disabled`: setting.

stop_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, cause this achievement to switch to its “stopped” state. These events will also cause the achievement to play the show defined in the `show_when_stopped`: setting and to emit (post) events in the `events_when_stopped`: setting.

reset_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, cause this achievement to reset back to its default state (which will either be “disabled” or, if you have `start_enabled`: true, “enabled”)

Events posted by achievements

You can configure achievements to post certain events when they change state.

Note that all achievements will by default post events in the form *achievement_(name)_state_(state)* when they change state. The events listed below, if defined, will replace the default event.

events_when_enabled:

List of one (or more) names of events. Default: achievement_(name)_state_enabled.

A single event, or a list of events, that will be posted when this achievement is enabled.

events_when_selected:

New in version 0.32.

List of one (or more) names of events. Default: achievement_(name)_state_selected.

A single event, or a list of events, that will be posted when this achievement is selected.

events_when_started:

List of one (or more) names of events. Default: achievement_(name)_state_started.

A single event, or a list of events, that will be posted when this achievement is started.

events_when_completed:

List of one (or more) names of events. Default: achievement_(name)_state_completed.

A single event, or a list of events, that will be posted when this achievement is complete.

events_when_disabled:

List of one (or more) names of events. Default: achievement_(name)_state_disabled.

A single event, or a list of events, that will be posted when this achievement is disabled.

events_when_stopped:

List of one (or more) names of events. Default: achievement_(name)_state_stopped.

A single event, or a list of events, that will be posted when this achievement is stopped.

Shows

The following settings control which show is played when this achievement switches to a new state.

Note that whatever show was playing from the previous state will be stopped.

Also, any tokens configured in the show_tokens: section will be passed to the show here.

show_when_enabled:

Single value, type: string. Default: None

Name of the show that will be started when this achievement has been enabled.

show_when_selected:

New in version 0.32.

Single value, type: string. Default: None

Name of the show that will be started when this achievement has been selected.

show_when_started:

Single value, type: string. Default: None

Name of the show that will be started when this achievement has been started.

show_when_completed:

Single value, type: string. Default: None

Name of the show that will be started when this achievement has been completed.

show_when_disabled:

Single value, type: string. Default: None

Name of the show that will be started when this achievement has been disabled.

show_when_stopped:

Single value, type: string. Default: None

Name of the show that will be started when this achievement has been stopped.

sync_ms:

Single value, type: number. Default: None

A `sync_ms` value used for any shows which are started by this achievement. See the [full `sync_ms` documentation for details](#).

achievement_groups:

Config file section

New in version 0.32.

Valid in <i>machine config files</i>	NO
Valid in <i>mode config files</i>	YES

The `achievements_groups:` section of your config is where you configure grouping of multiple *player-based “achievement” tracking*.

Like most things in MPF configs, the highest-level entries in the `achievement_groups:` section of your config are the names of the individual achievement group, and then indented under each of those are the settings for that group.

Here’s an example `achievement_groups` section from Brooks & Dunn. (This is related to the example in the `achievements` config documentation.)

```

achievement_groups:
  my_group:
    achievements: world_tour, money_bags, music_awards, jukebox, play_poker
    enable_events: enable_mission_selection
    start_selected_events: shot_lower_vuk_from_playfield_hit
    select_random_achievement_events: rotate_mission_rotator
    events_when_enabled: mission_rotator_ready
    rotate_right_events: sw_toggle
    show_tokens:
      leds:
        l_begin_round
    show_when_enabled: flash

```

More examples:

- *Recipe: The Addams Family Mansion Awards*
- *achievement (example config files)*

General Settings

achievements:

List of one (or more) values, each is a type: string. Default: None

This is a list of the achievements (from the `achievements:` section of your mode config) that make up this group. The order here defines the order individual achievements are rotated in via the `rotate_right_events:` and/or `rotate_left_events:` settings.

allow_selection_change_while_disabled:

New in version 0.33.

Boolean (yes/no or true/false) setting. Default is False.

Controls whether the currently selected achievement can be changed when the achievement group is disabled. If False/No, then the rotate and select random events will have no effect when the group is disabled.

auto_select:

New in version 0.32.3.

Boolean (yes/no or true/false) setting. Default is False.

If True, this achievement group will automatically ensure that one of its member achievements is always selected. The selected achievement will be chosen at random from all the achievements in the “enabled” states (and the “stopped” states if `restart_after_stop_possible:` is set to True).

disable_while_achievement_started:

New in version 0.32.3.

Boolean (yes/no or true/false) setting. Default is True.

If True, this achievement group will automatically disable itself when any of its member achievements are in the “started” states. This is the default behavior because an achievement group is typically used to select an achievement to run, and while an achievement is running, you usually want to disable the selection process for the next achievement.

enable_while_no_achievement_started:

New in version 0.32.3.

Boolean (yes/no or true/false) setting. Default is True.

If True, this achievement will automatically enable itself when none of its member achievements are in the “started” states. This is the default behavior because an achievement group is typically used to select an achievement to run, so when none are running, you want to enable the group so that the next achievement can be selected.

show_tokens:

One or more sub-entries, each in the format of type: str:str. Default: None

This is an indented list of key/value pairs for the *show tokens* that will be sent to the shows that are played when this achievement changes state.

Note that you can configure `show_tokens:` at the group level (here) or the individual achievement level. That’s done for convenience, and in practical use, you’d just configure the show tokens in one place.

Control Events

The following settings specify which MPF events cause the achievements in this group to move to a new state.

enable_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. See the *Device Control Events* documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, will enable this achievement group. This will play the `show_when_enabled:` and will post events in the `events_when_enabled:` settings.

This will also check to see if all the member achievements are complete, it will check to see if there are no more enabled achievements, and it will update the selected achievement.

Starting the selected achievement only works if the group is enabled. In other words, if something has to be “lit” before an achievement can start, then that is done via the group’s “enable” functionality.

disable_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. See the *Device Control Events* documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, disable this achievement group. These events will also cause the achievements to play the show defined in their `show_when_disabled:` setting and to emit (post) events in their `events_when_disabled:` settings.

start_selected_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. See the *Device Control Events* documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, cause any achievements in this group that are in the “selected” state to switch to their “started” state. (Typically there would only be a single achievement in the group that’s “selected” at any time, but you could have more than one.)

These events only work if the achievement group is enabled.

When the individual achievements change from “selected” to “started”, they will play their `show_when_started:` shows and post their `events_when_started:` events.

select_random_achievement_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. See the *Device Control Events* documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, will randomly pick one of the available achievements and change it to its “selected” state. This is useful when a game is starting and you want one of the available achievements to start in a selected state. (e.g. pick a random mission to be highlighted.)

Note that the `allow_selection_change_while_disabled`: controls whether these events will work when the achievement group is disabled.

The “available” achievements which could be chosen here include achievements that are one of the following:

- enabled
- selected
- stopped (if the achievement’s `restart_after_stop_possible`: is true/yes

An example of this would be in Attack From Mars, where the next country is randomly chosen (selected) after you default the saucer for the previous country.

If there are no more available events to be selected, then the events in `events_when_no_more_enabled`: are posted.

Note that if you want to always select a certain achievement (instead of randomly picking one), then you can just set that particular achievement’s `select_events`: entry rather than using this random selecting setting.

rotate_right_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Causes the states of the available achievements in this group to be rotated to the right.

Note that the `allow_selection_change_while_disabled`: controls whether these events will work when the achievement group is disabled.

This is used to “switch” the current selected achievement. For example, many games have main achievements you need to complete to get to wizard mode. Completed achievements have a light that’s solid on, available (enabled) achievements have a light that’s off (since they’re not yet complete but available to be played), and the current selected achievement has a light that’s flashing (indicating that it’s the next one to be played).

Then when you hit a slingshot or pop bumper, the currently selected (flashing) achievement changes, but you only want to rotate with other achievements that are enabled (available but not yet complete).

So if this is the current state:

- Mission 1: completed
- Mission 2: selected
- Mission 3: enabled
- Mission 4: enabled
- Mission 5: enabled

And then one of the `rotate_right_events`: is posted (like from a pop bumper hit), the new list would look like this:

- Mission 1: completed
- Mission 2: enabled

- Mission 3: selected
- Mission 4: enabled
- Mission 5: enabled

Notice that the “selected” state moved from Mission 2 to Mission 3, and the completed state of Mission 1 did not change.

Even though these are called “rotate” events, what really happens is that when this rotation occurs, the previously selected achievement changes from “selected” to “enabled”, and the newly selected achievement changes from “enabled” to “selected”. Both achievements will stop their current shows and play the shows associated with their new states, and both will post the events associated with their new states.

Note that if you want to select a random achievement instead of the next one on the list, you can use a `select_random_achievement_events: event` instead.

rotate_left_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Same as `rotate_right_events:`, but it rotates the selected achievement in the opposite direction.

Events posted by achievements

You can configure achievements to post certain events when they change state.

Note that all achievements will always post events in the form `achievement_(name)_state_(state)` when they change state. The events listed below are in addition to that event.

events_when_enabled:

List of one (or more) values, each is a type: string. Default: None

A single event, or a list of events, that will be posted when this achievement group is enabled.

events_when_all_completed:

Changed in version 0.32.3.

Prior to MPF 0.32.3, this event was called “events_when_all_complete”. This was a mistake since the completed state is called “completed”, not “complete”

List of one (or more) values, each is a type: string. Default: None

A single event, or a list of events, that will be posted when all the achievements in this group are in the “completed” state. This is useful for posting events to start a wizard mode, for example.

events_when_no_more_enabled:

List of one (or more) values, each is a type: string. Default: None

A single event, or a list of events, that will be posted when one of the events in the `select_random_achievement:` is posted but there are no more available achievements to be selected.

Shows

The following settings control which show is played when this achievement switches to a new state.

Note that whatever show was playing from the previous state will be stopped.

Also, any tokens configured in the `show_tokens:` section will be passed to the show here.

show_when_enabled:

Single value, type: string. Default: None

Name of the show that will be started when this achievement group has been enabled.

animations:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES

The `animations:` section of your config is where you list the reusable “named” animations.

Note that while you can add animations in both the machine-wide and a mode-specific config, the list of animations is global, meaning that any animation is available in any mode, and you can’t have two different animations with the same name.

For example:

```
animations:
  fade_in:
    property: opacity
    value: 1
    duration: 1s
  fade_out:
    property: opacity
    value: 0
    duration: 1s
```

The above example defines animations named `fade_in` and `fade_out` that you can use, by name, in any widget or `widget_player` config where you would ordinarily define your own animations.

See the [How to animate display widgets](#) for more details.

assets:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES

The `assets:` section of a config file lets you configure the default settings for different types of assets based on what folder those assets are in. Any settings you specify here are just the defaults, though, and you can still override the defaults for an individual asset by adding an entry for it to your machine or mode config file.

Let's take a look at an example:

```
assets:
  images:
    default:
      load: preload
    preload:
      load: preload
    on_demand:
      load: on_demand
    potato:
      some_key: some_value
      something_else: whatever
```

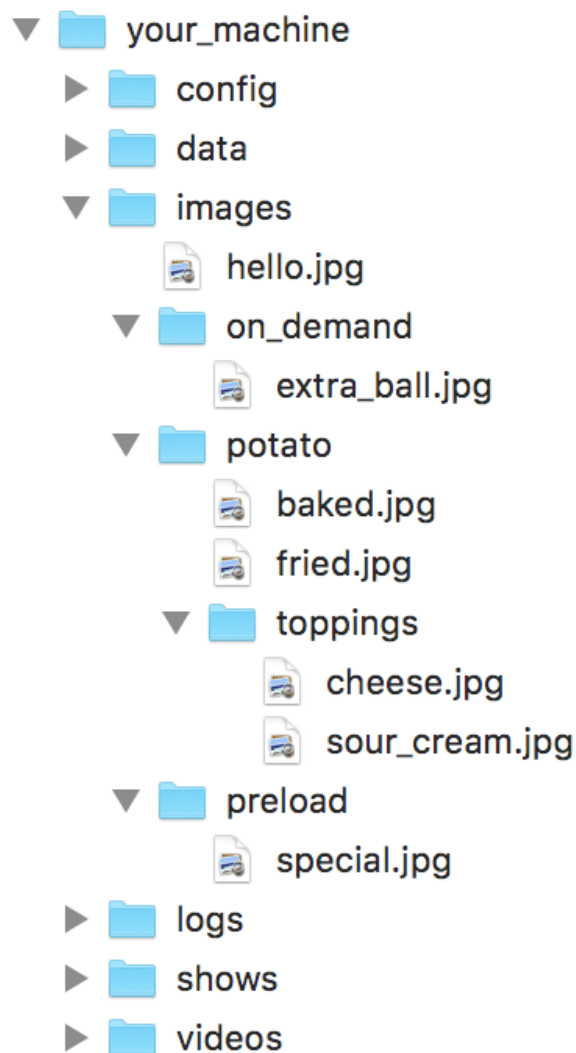
The above config contains the asset settings for *image* assets. Notice there are 4 entries under `images::` `default`, `preload`, `on_demand`, and `potato`. Those names represent sub-folders that could contain image assets.

Then under each of those, there are one or more key/value pairs. These key/value pairs are applied to assets located in the sub-folders above.

Note: Although you can create sub-folders nested as many levels deep as you wish, only the top-level sub-folder can be listed in the `assets` section. Any assets in sub-folders below the top level will inherit the settings from their top-level sub-folder parent.

The `default` entry is special, as it applies to the root folder as well as any assets that are in folders that are not specified here.

Consider the following files & folders in a machine folder with the `assets:` section from above:



In this case, `/your_machine/images/hello.jpg` would have the default: settings applied, `/your_machine/images/preload/special.jpg` would have the `load: preload` key/value pair applied to it, `/your_machine/images/potato/toppings/cheese.jpg` would have the `some_key: some_value` and `something_else: whatever` key/value pairs applied to it, etc.

The `assets:` section of the config file doesn't really care what the key/value pairs are. They're just the defaults for the assets in those folders, and if they're not valid settings then MPF will give you an error. (Note that different types of assets have different settings options and different keys & values that are correct.)

Currently MPF supports four kinds of assets. Click on each to go to that asset type's description in the config file reference which will explain what settings and be used and what the options are.

Asset types include:

- [file_shows:](#)
- [images:](#)
- [sounds:](#)
- [videos:](#)

auditor:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The *auditor:* section of the machine configuration file lets you control what events the MPF's auditor module includes in its audits.

Here's an example which is the settings we including in the default *mpfconfig.yaml* file. (So these are the settings that are included by default with every game you run.) Also, by default, the auditor saves its audits to /audits/audits.yaml in the folder for each machine. (Check out the documentation on the Auditor to see a sample audit log file.)

```
auditor:
  save_events:
    ball_ended
    game_ended
  audit:
    shots
    switches
    events
    player
  events:
    ball_search_begin
    machine_init_phase_1
    game_started
    game_ended
    machine_reset
  player:
    score
  num_player_top_records: 10
```

Optional settings

The following sections are optional in the *auditor:* section of your config. (If you don't include them, the default will be used).

audit:

List of one (or more) values, each is a type: string. Default: None

This is a list of the various types of things you want to include in your audit file. There are currently four options:

- shots - tracks the number of times each shot has been made
- switches - tracks the number of times each switch has been hit.
- events - whether the auditor should audit certain events. (Add the events you want to track to the *events* section.)

- **player** - includes player variables (score, maybe shots or goals they've achieved, etc.) See the *player* section below for details.

events:

List of one (or more) values, each is a type: string. Default: None

A list of which events you want to audit. These are the names of any events you want.

num_player_top_records:

Single value, type: integer. Default: 1

For player-specific variables, you have the option of track the “top” number of each. So in the example above, since the only player item is *score*, the auditor will track the top 10 highest scores, plus the total count and the overall average.

player:

List of one (or more) values, each is a type: string. Default: None

A list of player variables you want to audit. The auditor will save a certain number (configurable via the *num_player_top_records*: setting), as well as the total number of entries and the current average.

save_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the *Device Control Events* documentation for details on how to enter settings here.

Default: *ball_ended*

Events in this list, when posted, trigger the auditor to save its audits to disk.

autofire_coils:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The *autofire_coils*: section of your config file contains all the settings for the coils which you would like to fire automatically based on a switch activation in a pinball machine.

Here's an example:

```
autofire_coils:
  left_sling:
    coil: c_left_sling
    switch: s_left_sling
  right_sling:
```



```
coil: c_right_sling
switch: s_right_sling
```

Note that autofire coils in MPF are 1-to-1 in terms of coils-to- switches, so a single entry is for one switch to control one coil. On some platforms, you can have two switches control a single coil (or two coils controlled by a single switch), but to do that you would create two separate *autofire_coils:* entries with one coil and one switch each. (And again, that's platform-specific. Check your hardware platform documentation for details.)

If you're wiring your slingshots and you want two switches to control a single coil, on nearly 100% of pinball machines in the world, those two switches are wired together and use a single input, so the hardware sees them as a single switch. (Just be sure to wire them in parallel, not series, so that either switch closing causes the hardware to see the switch activation.) The top-level setting is the name you can refer to this autofire coil as, such as `left_sling:` or `right_sling:` in the example above.

Then each entry has the following required and optional settings:

Required settings

The following sections are required in the `autofire_coils:` section of your config:

<name>:

The name of the ball device. (`left_sling` and `right_sling` in the example config above.)

The rest of the settings here apply to individual ball devices (and are indented under them).

coil:

Single value, type: string name of a coils: device.

The name of the coil you want to fire. (Actually, perhaps we should phrase it as the name of the coil you want to change the state on, because you can also use these autofire coil rules to cause coils to stop firing based on a switch change.)

switch:

Single value, type: string name of a switches: device.

Optional settings

The following sections are optional in the `autofire_coils:` section of your config. (If you don't include them, the default will be used).

coil_overwrite:

One or more sub-entries, each in the format of type: str:str. Default: None

Todo: Add description.

debug:

Single value, type: boolean (Yes/No or True/False). Default: False

See the [documentation on the debug setting](#) for details.

disable_events:

Changed in version 0.32.

List of one or more events (with optional delay timings), in the [device control events](#) format.

Default: ball_ending, service_mode_entered (Note that if you add an entry here, it will replace the default. So if you also want the default value(s) to apply, add them too.)

Disables this autofire coil by clearing the hardware rule from the pinball controller hardware.

enable_events:

List of one or more events (with optional delay timings), in the [device control events](#) format.

Default: ball_started (Note that if you add an entry here, it will replace the default. So if you also want the default value(s) to apply, add them too.)

Enables this autofire coil by writing the hardware rule to the pinball controller hardware.

label:

Single value, type: string. Default: %

The plain-English name for this device that will show up in operator menus and trouble reports.

reverse_switch:

Single value, type: boolean (Yes/No or True/False). Default: False

Boolean which controls whether this autofire device fires when the switch is active or inactive. The default behavior is that the coil is fired when the switch goes to an active state. If you want to reverse that, so the coil fires when the switch goes to inactive, then set this to False. (This is what you would use if you have an opto.) Default is *False*.

switch_overwrite:

One or more sub-entries, each in the format of type: str:str. Default: None

Todo: Add description.

tags:

List of one (or more) values, each is a type: string. Default: None

Special / reserved tags for autofire coils: *None*

See the [documentation on tags](#) for details.

ball_search_order:

Numeric value, default is 100

New in version 0.33.

A relative value which controls the order individual devices are pulsed when ball search is running. Lower numbers are checked first. Set to 0 if you do not want this device to be included in the ball search. See the [Ball Search](#) documentation for details.

playfield:

New in version 0.33.

The name of the playfield that this autofire device is on. The default setting is “playfield”, so you only have to change this value if you have more than one playfield and you’re managing them separately.

ball_devices:

Config file section

Valid in machine config files	YES
Valid in mode config files	NO

The ball_devices: section of your config is where you configure your [ball devices](#).

Optional settings

The following sections are optional in the ball_devices: section of your config. (If you don’t include them, the default will be used).

auto_fire_on_unexpected_ball:

Single value, type: boolean (Yes/No or True/False). Default: True

If a ball randomly shows up in this device, should it be automatically ejected?

ball_capacity:

Single value, type: integer. Default: None

Optional value for how many balls this device can hold. You only need to specify this if your device holds more balls than it has *ball_switches* for. (In other words, probably 99% of the ball devices in the world don't need this because they have one switch for each ball.) Some devices, like the Dead World lock in *Judge Dredd* or the gumball machine in *Twilight Zone* don't have a 1-to-1 mapping for ball switches to balls held, so you would use this setting to tell MPF how many balls that device can hold. Default will be set to the number of *ball_switches* there are.

ball_missing_target:

Single value, type: string name of a playfields: device. Default: playfield

When a ball goes missing from a device, this is the name of the ball device that will get the ball added to it. (After all, the ball didn't just vaporize. It went somewhere.) The default is *playfield*. (In other words, if a ball disappears from a device, MPF assumes it's on the playfield unless you specify a different device here.) Most devices have ball switches which means that a ball which disappears from a device that only has an exit to another device will be picked up by that device. But if you have a device that leads into another device that doesn't know how many balls it has, or if you have multiple playfields, you can set that target here. Default is *playfield*.

ball_missing_timeouts:

List of one (or more) values, each is a type: time string (ms) (*Instructions for entering time strings*) . Default: 20000ms

A list of timeouts that correspond to how much time after a ball goes missing passes before MPF assumes that ball went into this device's target device. This is a list, so you can enter multiple values to match the multiple entries in your *eject_targets*: list. If you don't enter a value here, or if the number of values you enter here are less than the number of eject targets this device has, MPF use 20 seconds as the default.

ball_search_order:

Single value, type: integer. Default: 200

A relative value which controls the order individual devices are pulsed when ball search is running. Lower numbers are checked first. Set to 0 if you do not want this device to be included in the ball search. See the [Ball Search](#) documentation for details.

ball_switches:

List of one (or more) values, each is a type: string name of a switches: device. Default: None

A list of switch names that are active when a ball is in the device. It's assumed there is a one-to-one *ball switch* to *ball* ratio, so if you have three switches then MPF assumes that device can hold three balls. (Note that if your device can hold more balls than it has switches for, like the gumball machine in *Twilight Zone* , then you can use the *ball_capacity*: setting to specify how many balls it can hold.)

MPF uses these switches to count how many balls a device has at any time by counting how many of them are active. Note that “active switch” means “there is a ball here.” So if you have a trough with opto switches which “invert” their state, then you will have to configure those switches with the “NC” (normally closed) type in the switches: section of your config file. Default is *None* . (Meaning this device tracks the number of balls it has virtually based on *entrance_switch* activations.)

`captures_from:`

Single value, type: string name of a playfields: device. Default: playfield

This is the name of the ball device that this device captures balls from. In other words, if a ball randomly appears in this device, it assumes it came from this *captures_from* device. Default is *playfield*.

`confirm_eject_event:`

List of one or more events (with optional delay timings), in the *device control events* format. Default: *None* (Note that if you add an entry here, it will replace the default. So if you also want the default value(s) to apply, add them too.)

This is the name of the event that will be used to confirm a successful ball eject if you have *confirm_eject_type: event*. Default is *None*.

`confirm_eject_switch:`

List of one or more events (with optional delay timings), in the *device control events* format. Default: *None* (Note that if you add an entry here, it will replace the default. So if you also want the default value(s) to apply, add them too.)

This is the name of the switch activation that will be used to confirm a successful ball eject if you have *confirm_eject_type: switch*. Default is *None*.

`confirm_eject_type:`

Single value, type: one of the following options: target, switch, event, fake. Default: target

Whenever the a ball device attempts to eject a ball, it needs to verify that the ball was actually ejected properly. There are several ways that eject verification can take place, and this option allows you to specify which verification method you want. Note that many of these options require further configuration settings. Options for confirming the eject include:

- **target** (default) - This device will confirm the eject via a ball successfully entering the “target” device it was ejecting the ball to. (The target device is one of the entries from your *eject_targets:* list and can either be a *ball device* or the *playfield*. Note that if the target device is a playfield and the playfield already has an active ball, then the eject confirmation will be changed to *count* since it wouldn’t know if a playfield switch being hit was based on the newly-ejected ball or one of the existing playfield balls.
- **event** - The ball device will look for a specific event, and when it sees that event, it knows the eject was successful. This can be any event you want, specified via the *confirm_eject_event:* setting.

- **switch** - If your ball device has a switch which is activated when the ball exits, you can use this *switch*type of confirmation*. Then when the ball device sees this switch become active (even if it's momentary), it knows the eject was successful. An example of this might be if there's a switch on the ball gate at the top of a plunger lane. Note that you only want to use this type of eject confirmation if the eject confirmation switch cannot be activated by balls on the playfield. Otherwise if you're trying to eject a ball when you already have one in play, you wouldn't know if the newly-ejected ball hit that switch or if an existing live ball hit it. This can be any switch you want, specified via the **confirm_eject_switch*: setting.
- **fake** - This is a setting that's used by other devices (such as the ball lock) when they do not want to use eject confirmation because they have another way of confirming the eject. It's not an option that you would use when setting up devices, but it's included here in case you happen to see a reference to it in the code or the log files.

debug:

Single value, type: boolean (Yes/No or True/False). Default: False

See the [documentation on the debug setting](#) for details.

eject_all_events:

List of one or more events (with optional delay timings), in the [device control events](#) format.

Default: None (Note that if you add an entry here, it will replace the default. So if you also want the default value(s) to apply, add them too.)

Causes this device to eject all its balls.

eject_coil:

Single value, type: string name of a coils: device. Default: None

The coil that is fired to eject a ball from this device. This *eject_coil* is optional, since some devices (like a manual plunger or the playfield) don't have eject coils. Default is *None*.

eject_coil_jam_pulse:

Single value, type: time string (ms) ([Instructions for entering time strings](#)) . Default: None

This is the pulse time, in ms, that the eject coil will use if the jam switch is active and the first eject attempt failed to eject the ball. (In other words, if the jam switch is active, the ball device will try to eject the ball with the regular pulse time. If that fails, then subsequent ejects will use this pulse time instead. Default is *None* which means the ball device will not change the pulse time after 2 attempts.

eject_coil_retry_pulse:

Single value, type: time string (ms) ([Instructions for entering time strings](#)) . Default: None

The new pulse time, in ms, that the eject coil will use if the eject has failed too many times. This pulse time is used up until the device stops trying. Default is *None* which means the ball device will not change the pulse time after failed attempts.

Note that the number of times the ball device will attempt the eject before increasing the pulse time is controlled in the `retries_before_increasing_pulse`: setting.

`retries_before_increasing_pulse`:

Single value, type: number. Default: 4

New in version 0.33.

The number of times this ball device will attempt to eject the ball before increasing the eject coil pulse time as specified in the `eject_coil_retry_pulse`: above.

Note that this number is the attempts that it will increase the pulse, so the default setting of 4 means that it will try the original pulse value 3 times and then increase it on the 4th.

`eject_events`:

List of one or more events (with optional delay timings), in the *device control events* format.

Default: *None* (Note that if you add an entry here, it will replace the default. So if you also want the default value(s) to apply, add them too.)

Causes this device to eject one ball.

`eject_targets`:

List of one (or more) values, each is a type: string name of a ball_devices: device. Default: playfield

A list of one or more ball devices and/or the word “playfield” which is used to specify all the ball devices this device can directly eject a ball to. This is a very important concept and can be somewhat confusing, so bear with us as we try to explain it.

Every time a ball device ejects a ball, MPF needs to “confirm” that the ball was successfully ejected. There are several different methods which can be used to confirm the eject, and you configure which method you want to use for each ball device via the `confirm_eject_type`: setting.

In many cases, it’s possible that a single ball device can actually eject a ball into one of several different targets. For example, in *Star Trek: The Next Generation*, the main plunger catapult fires the ball into the top of the playfield where there is a controlled drop target blocking the entrance to a subway. If that drop target is up, then the ball bounces off it and then is live on the playfield. If that drop target is down, a ball ejected from the catapult flies past it and into the subway. Once in the subway, there is a series of diverters which can activate or deactivate to route the ball to either the *left VUK*, the *leftcannon*, or the *right cannon*. In that machine, the *left VUK*, *left cannon*, and *right cannon* are all ball devices. So the `eject_targets`: setting looks like this:

```
eject_targets: playfield, bd_leftVUK, bd_leftCannonVUK, bd_rightCannonVUK
```

In other words, the `eject_targets`: list is a list of *all possible ball devices* that this device can eject a ball to.

Notice that the word *playfield* is also in that list, because if that drop target is up, then the ball ejected from the catapult ends up on the playfield, so *playfield* is a valid target too. (In MPF, the playfield is also a ball device.)

At this point you might be wondering what the point of this is? The reason you specify all these target devices is because MPF's ball controller and ball device code work hand-in-hand with MPF's diverter code to automatically "route" balls to ball devices that want them. So in *Star Trek*, you can use a command to say "the left VUK should have one ball," and MPF will see the source device for that ball (the *catapult*, in this case, since it includes *bd_leftVUK* in its list of eject targets) and it will cause the catapult to eject a ball. (What's happening behind the scenes is that the catapult posts an event which says "I'm ejecting a ball with a target destination of the **bd_leftVUK*"), and all the diverters (including that top drop target) will see that and automatically position themselves accordingly so the ball gets to where it needs to go.

Note that you only want to include devices in this list that are directly accessible as targets for balls ejecting from this device. In other words your machine will probably have lots of ball locks and other devices that the player can hit via flippers and balls from the playfield. Those devices should not be on this list, because technically balls enter them from the playfield, not from the catapult.

The order of your *eject_targets*: list doesn't really matter except for the first entry. If a ball device is ever asked to eject a ball but a target is not specified, then the first entry on this list will be used as the target. (In practice this shouldn't really ever happen.)

eject_timeouts:

List of one (or more) values, each is a type: time string (ms) (*Instructions for entering time strings*) . Default: None

This is an optional list of one or more MPF time strings that specify how long the device should wait for an ejected ball to be confirmed before it assumes the eject failed. The order you enter them here matches up with the order of your *eject_targets*. For example, consider the following two lines from a ball device configuration:

```
eject_targets: playfield, bd_leftVUK, bd_leftCannonVUK, bd_rightCannonVUK
eject_timeouts: 500ms, 2s, 4s, 4s
```

When this device is ejecting a ball to the *playfield*, the timeout will be *500ms*. When it's ejecting to the *bd_leftVUK*, the timeout is *2 seconds*, etc. If you don't specify a list of eject timeouts, or if the length of the list is less than the number of eject targets, then the default value of *10 seconds* is used.

entrance_count_delay:

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: 500ms

This is the time delay (in MPF time string format) that this ball device will wait before counting the balls after any of the *ball_switches* changes state. This delay exists because there's often a "settling time" when a ball first enters a device where the balls are bouncing around and the switches change state really fast. Default is *500ms*.

entrance_events:

List of one or more events (with optional delay timings), in the *device control events* format.

Default: None (Note that if you add an entry here, it will replace the default. So if you also want the default value(s) to apply, add them too.)

These events tell this ball device that a ball has entered (been added to) the device.

entrance_switch:

Single value, type: string name of a switches: device. Default: None

The name of a switch that is activated when a ball enters the device. Most devices don't have this, since they have the ball switches that are updated and will count the balls. But some devices, like those that do not have switches for each ball, have a switch at the entrance that is triggered when a ball enters. This switch has no effect if your ball device has *ball_switches*. Default is *None*.

entrance_switch_full_timeout:

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: 0

Todo: Add description.

exit_count_delay:

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: 500ms

This is the time delay that the device will wait before counting the balls after any after it attempts to eject a ball if the device is configured to verify the eject via a count of the switches.

hold_coil:

Single value, type: string name of a coils: device. Default: None

The name of a coil that is held in the enabled position to hold a ball. This is used in place of an *eject_coil*, and it's for devices that have to hold (like a post) to keep a ball in the device. Disabling the hold coil releases a ball. Default is *None*.

hold_coil_release_time:

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: 1s

This is the time (in MPF time string format) that devices with *hold_coils* will hold their coil open to release a ball. Default is *1 second*.

hold_events:

List of one or more events (with optional delay timings), in the *device control events* format.

Default: None (Note that if you add an entry here, it will replace the default. So if you also want the default value(s) to apply, add them too.)

These events cause this device to enable its hold coil.

hold_switches:

List of one (or more) values, each is a type: string name of a switches: device. Default: None

A switch (or list of switches) that indicates a ball is in position to be captured by a *hold_coil*. Default is *None*.

jam_switch:

Single value, type: string name of a switches: device. Default: None

Some pinball trough devices have a switch in the “exit lane” part of the trough that can detect if a ball fell back into the trough from the plunger lane. (The extra switch is needed because when the trough ejects the ball, the remaining balls in the trough will all roll down, so if the ejected ball falls back in, it ends up sitting “on top” of the existing balls, so a normal trough ball switch won’t see it.)

This switch is known by different names by different manufacturers, having variously been called *trough jam*, *ball up* switch, or *ball stacked* switch. If your ball device has a switch that can detect jams, enter that switch name here. The ball device code in the MPF has a jam switch handler which watches what happens to that switch. For example, if there’s an eject in progress and the jam switch becomes active, it assumes the ball fell back in and will try the eject again.

label:

Single value, type: string. Default: %

The plain-English name for this device that will show up in operator menus and trouble reports.

max_eject_attempts:

Single value, type: integer. Default: 0

Defines how many times this ball device will attempt to eject a ball before deciding that the eject permanently failed. A value of zero Default is 0 which means there’s no limit. (e.g. the device will just keep trying to eject the ball forever.)

mechanical_eject:

Single value, type: boolean (Yes/No or True/False). Default: False

Boolean setting which is used to specify whether this ball device has a mechanical eject option. In MPF, a *mechanical eject* is what happens when a player is able to eject a ball from the ball device mechanically, without MPF knowing about it. (A traditional spring- powered plunger is the most common use.) This setting is used because when a mechanical eject happens, from MPF’s standpoint it’s like the ball just disappeared, so this setting is used to let MPF know that that might happen. Set this to *True* if a mechanical eject is an option for this ball device. Note that it’s entirely possible to have devices that support both mechanical ejects as well as coil-fired ejects (with an *eject_coil*), such as a plunger lane with a spring plunger and a coil-fired collar which can be used in auto or manual

mode. Default is *False*. However, if this device does not have an *eject_coil* or *hold_coil* defined, then the *mechanical_eject* setting will automatically be set to *True*.

player_controlled_eject_event:

Single value, type: string. Default: None

Todo: Add description.

request_ball_events:

List of one or more events (with optional delay timings), in the *device control events* format.

Default: None (Note that if you add an entry here, it will replace the default. So if you also want the default value(s) to apply, add them too.)

These events cause this device to request a ball to be sent to it.

tags:

List of one (or more) values, each is a type: string. Default: None

See the *documentation on tags* for details.

Special-purpose tags for ball devices include:

- *home* - Specifies that any balls here are “home” and that the game can start. When MPF boots up, any balls that are in devices not tagged with “home” are automatically ejected.
- *ball_add_live* - Used to tag the device you want to use to launch new balls into play. Typically this is the plunger device.
- *drain* - Specifies that a ball entering this device means the ball has “drained” from the playfield. (i.e. it’s used to indicate a player lost the ball, versus some other random playfield lock.)
- *trough* - Specifies that this device holds the ball(s) that are not in play. In most cases, your “drain” and “trough” tags will be the same device, though older games (Williams System 11 and early WPC) actually have two devices under the apron, with a “drain” device receiving balls from the playfield which it then immediately kicks over to a “trough” device which holds the balls that are not in play.

target_on_unexpected_ball:

Single value, type: string name of a ball_devices: device. Default: None

Todo: Add description.

ball_holds:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES

New in version 0.33.

The ball_holds: section of your config is used to list and configure *ball holds*.

Note that ball holds are used to temporarily hold a ball while the game is doing something else. (Starting a video mode, playing an intro show, etc.) If you want to hold and lock a ball towards multiball, use the ball_locks: section instead.

Ball holds do not affect the “balls in play” count, and they are not used to hold balls from ball-to-ball or between players.

Here’s an example

```
ball_holds:
  bunker:
    balls_to_hold: 1
    hold_devices: bd_bunker
```

Each sub-entry under the ball_holds: section is the name of the logical ball hold (“bunker”) in the example above. Then each named ball hold has the following settings:

Required settings

The following sections are required in the ball_holds: section of your config:

hold_devices:

List of one (or more) values, each is a type: string name of a ball_devices: device.

A list of one (or more) ball devices that will collect balls which will count towards this hold.

Optional settings

The following sections are optional in the ball_holds: section of your config. (If you don’t include them, the default will be used).

balls_to_hold:

Single value, type: integer. Default: None

The number of balls this ball hold should hold. If you don’t include it, then the ball hold capacity will be automatically calculated based on the combined capacity of all the ball devices that make up this ball hold.

If one of the associated hold devices receives a ball and this ball hold is full, then the ball device will just release the ball again.

debug:

Single value, type: boolean (Yes/No or True/False). Default: False

See the [documentation on the debug setting](#) for details.

disable_events:

List of one or more events (with optional delay timings), in the [device control events](#) format.

Default: None (Note that if you add an entry here, it will replace the default. So if you also want the default value(s) to apply, add them too.)

Event(s) which disable this ball hold.

enable_events:

List of one or more events (with optional delay timings), in the [device control events](#) format.

Default: None (Note that if you add an entry here, it will replace the default. So if you also want the default value(s) to apply, add them too.)

Event(s) which enable this ball hold.

label:

Single value, type: string. Default: %

A descriptive label.

release_one_if_full_events:

List of one or more events (with optional delay timings), in the [device control events](#) format.

Default: None (Note that if you add an entry here, it will replace the default. So if you also want the default value(s) to apply, add them too.)

Event(s) which cause this ball hold to release a single ball only if the ball hold contains the number of balls that matches its balls_to_hold: setting.

release_one_events:

List of one or more events (with optional delay timings), in the [device control events](#) format.

Default: None (Note that if you add an entry here, it will replace the default. So if you also want the default value(s) to apply, add them too.)

Event(s) which cause this ball hold to release a single ball.

reset_events:

List of one or more events (with optional delay timings), in the *device control events* format.

Default: machine_reset_phase_3, ball_starting, ball_will_end, service_mode_entered (Note that if you add an entry here, it will replace the default. So if you also want the default value(s) to apply, add them too.)

Event(s) which cause this ball hold to reset its held ball count.

Todo: more detail needed

source_playfield:

Single value, type: string name of a ball_devices: device. Default: playfield

The name of the playfield that feeds balls to this hold. If you only have one playfield (which is most games), you can leave this setting out. Default is the playfield called *playfield*.

tags:

List of one (or more) values, each is a type: string. Default: None

Special / reserved tags for ball holds: *None*

See the *documentation on tags* for details.

ball_locks:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES

Important: The “ball_locks config section will be removed after MPF 0.33. It’s been replaced with the *ball_holds:* and *multiball_locks:* sections which are available in MPF 0.33 and later.

The ball_locks: section of your config is used to list and configure *logical ball locks*.

Here’s an example

```
ball_locks:
  bunker:
    balls_to_lock: 3
    lock_devices: bd_bunker
```

Each sub-entry under the ball_locks: section is the name of the logical ball lock (“bunker”) in the example above. Then each named ball lock has the following settings:

Required settings

The following sections are required in the `ball_locks:` section of your config:

`balls_to_lock:`

Single value, type: integer.

The number of balls this ball lock should hold. If one of the associated lock devices receives a ball and this logical ball lock is full, then the ball device will just release the ball again.

`lock_devices:`

List of one (or more) values, each is a type: string name of a `ball_devices: device`.

A list of one (or more) ball devices that will collect balls which will count towards this lock.

Optional settings

The following sections are optional in the `ball_locks:` section of your config. (If you don't include them, the default will be used).

`debug:`

Single value, type: boolean (Yes/No or True/False). Default: False

See the [documentation on the debug setting](#) for details.

`disable_events:`

List of one or more events (with optional delay timings), in the [device control events](#) format.

Default: None (Note that if you add an entry here, it will replace the default. So if you also want the default value(s) to apply, add them too.)

Event(s) which disable this ball lock.

`enable_events:`

List of one or more events (with optional delay timings), in the [device control events](#) format.

Default: None (Note that if you add an entry here, it will replace the default. So if you also want the default value(s) to apply, add them too.)

Event(s) which enable this ball lock.

label:

Single value, type: string. Default: %

A descriptive label.

release_one_if_full_events:

New in version 0.32.

List of one or more events (with optional delay timings), in the *device control events* format.

Default: None (Note that if you add an entry here, it will replace the default. So if you also want the default value(s) to apply, add them too.)

Event(s) which cause this ball lock to release a single ball only if the ball lock contains the number of balls that matches its balls_to_lock: setting.

release_one_events:

List of one or more events (with optional delay timings), in the *device control events* format.

Default: None (Note that if you add an entry here, it will replace the default. So if you also want the default value(s) to apply, add them too.)

Event(s) which cause this ball lock to release a single ball.

request_new_balls_to_pf:

Single value, type: boolean (Yes/No or True/False). Default: True

Boolean which controls whether this logical ball lock will automatically add another ball into play after it locks a ball.

reset_events:

Changed in version 0.32.

List of one or more events (with optional delay timings), in the *device control events* format.

Default: machine_reset_phase_3, ball_starting, ball_will_end, service_mode_entered (Note that if you add an entry here, it will replace the default. So if you also want the default value(s) to apply, add them too.)

Event(s) which cause this ball lock to reset its locked ball count.

Todo: more detail needed

source_playfield:

Single value, type: string name of a ball_devices: device. Default: playfield

The name of the playfield that feeds balls to this lock. If you only have one playfield (which is most games), you can leave this setting out. Default is the playfield called *playfield*.

tags:

List of one (or more) values, each is a type: string. Default: None

Special / reserved tags for ball locks: *None*

See the [documentation on tags](#) for details.

ball_saves:

Config file section

Valid in machine config files	YES
Valid in mode config files	YES

The ball_saves: section of your config is where you create *ball save devices*. Here's an example:

```
ball_saves:
  default:
    active_time: 10s
    hurry_up_time: 2s
    grace_period: 2s
    enable_events: mode_base_started
    timer_start_events: balldevice_plunger_lane_ball_eject_success
    auto_launch: yes
    balls_to_save: 1
    debug: yes
```

<name>:

The name of this ball save device. (This is “default” in the config snippet above.) The name is used in the events that are posted from this ball save. (The complete list of events posted by ball saves is included in the events reference.)

Optional settings

The following sections are optional in the ball_saves: section of your config. (If you don't include them, the default will be used).

active_time:

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: 0

How long the ball save is active (in MPF time string format) once it starts counting down. This includes the *hurry_up_time*, but does not include the *grace_period* time. Leave this setting out (or set it to 0) for unlimited time. Default is 0.

auto_launch:

Single value, type: boolean (Yes/No or True/False). Default: True

True/False which controls whether the ball save should auto launch the saved ball or wait for the player to launch it.

balls_to_save:

Single value, type: integer. Default: 1

How many balls this ball saver should save before disabling itself. Set it to -1 for unlimited.

debug:

Single value, type: boolean (Yes/No or True/False). Default: False

Todo: Add description.

disable_events:

Changed in version 0.32.

List of one or more events (with optional delay timings), in the *device control events* format.

Default: ball_will_end, service_mode_entered (Note that if you add an entry here, it will replace the default. So if you also want the default value(s) to apply, add them too.)

Event(s) which disable this ball save, meaning a drained ball will no longer be saved.

enable_events:

List of one or more events (with optional delay timings), in the *device control events* format.

Default: None (Note that if you add an entry here, it will replace the default. So if you also want the default value(s) to apply, add them too.)

Event(s) which enable this ball save.

early_ball_save_events:

New in version 0.33.

List of one or more events (with optional delay timings), in the *device control events* format.

Event(s) which will trigger a ball save to take place before the current ball has drained. A typical example of this might be switch activation events from outlane switches which can be used to trigger a ball save as soon as the ball hits the outlane.

grace_period:

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: 0

The “secret” time (in MPF time string format) the ball save is still active. This is added onto the *active_time*. Default is 0.

hurry_up_time:

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: 0

The time before the ball save ends (in MPF time string format) that will cause the *ball_save_<name>_hurry_up* event to be posted. Use this to change the script for the light or trigger other effect. Default is 0.

label:

Single value, type: string. Default: %

The plain-English name for this device that will show up in operator menus and trouble reports.

source_playfield:

Single value, type: string name of a ball_devices: device. Default: playfield

Todo: Add description.

List of one (or more) values, each is a type: string. Default: None

Special / reserved tags for ball saves: *None*

See the *documentation on tags* for details.

timer_start_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the *Device Control Events* documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, start this ball saver’s countdown timer.

eject_delay:

New in version 0.31.

single|ms|0

TODO

only_last_ball:

New in version 0.31.

single|bool|False

TODO

delayed_eject_events:

New in version 0.33.

dict|str:ms|None

TODO

bcp:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The bcp: section of your config file controls how the MPF core engine communicates with the standalone media controller.

There's a default bcp: section in the default mpfconfig.yaml system-wide defaults section that should be fine to get started, and then you can override it if needed for a specific situation:

```
bcp:
  connections:
    local_display:
      host: localhost
      port: 5050
      type: mpf.core.bcp.bcp_socket_client.BCPCClientSocket
      required: True
      exit_on_close: True

  servers:
    url_style:
      ip: 127.0.0.1
      port: 5051
      type: mpf.core.bcp.bcp_socket_client.BCPCClientSocket

  player_variables:
    __all__
```



```
machine_variables:
  __all__

shots:
  __all__

debug: false
```

connections:

The *connections:* section is where you can specify the connections the MPF core engine will make to standalone media controllers. MPF supports connecting to multiple media controllers simultaneously which is why you can add multiple entries here.

The connections: section contains the following nested sub-settings

Optional settings

The following sections are optional in the connections: section of your config. (If you don't include them, the default will be used).

host:

Single value, type: string. Default: None

Todo: Add description.

port:

Single value, type: integer. Default: 5050

Todo: Add description.

type:

New in version 0.31.

TODO

event_map:

This section contains a list of MPF events that get mapped to BCP commands. You shouldn't have to change this. This is what MPF uses internally to map MPF events to the BCP command specification.

- *<event_name>*: The name of the MPF event you're creating a mapping for.
- *command*: The name of the BCP command that will be sent when the MPF event is posted.
- *params*: A list of parameters that will be passed via BCP along with this BCP command.

player_variables:

The *player_variables*: section lets you specify which MPF player variables will be broadcast via BCP to the media controller. (MPF will send these any time there's a change.) You can either list out the individual names of the players variables you want to send, like this:

```
player_variables:
    ball
    extra_balls
```

Or you can use the entry *__all__* (that's two underscores, the letters "all", then two more underscores) to send every change of every player variable to the media controller. Here's an example:

```
player_variables:
    __all__
```

servers:

New in version 0.31.

todo

ip:

New in version 0.31.

todo

Changed in version 0.33.

Starting in MPF 0.33, you can use *ip: None* and MPF will listen for incoming connections on all network interfaces.

port:

New in version 0.31.

todo

type:

New in version 0.31.

todo

required:

New in version 0.31.

TODO

exit_on_close:

New in version 0.32.

TODO

debug:

New in version 0.31.

TODO

bonus (mode_settings:)

Config File section

Valid in <i>machine config files</i>	NO
Valid in <i>mode config files</i>	YES

This section explains how to use the `mode_settings:` section for your machine's End of Ball Bonus mode. You should probably read the full *End of Ball Bonus* documentation first, and then just use this for a reference for the settings later.

Note that the “`mode_settings:`” section is pretty much a generic placeholder that any mode can use for its own custom settings. So the settings described here are specifically the settings that are used by MPF's built-in bonus mode, and so these settings are only valid in the bonus mode's mode configuration file.

Here's an example from *Brooks 'n Dunn*:

```
mode_settings:
  display_delay_ms: 4000
  hurry_up_delay_ms: 500
  hurry_up_event: flipper_cancel
  bonus_entries:
    - event: quarter_bonus
      score: current_player.quarters * current_player.album_value
    - event: wizard_bonus
      score: 25000
      player_score_entry: num_albums
```


Settings

display_delay_ms:

Time value, default 2s

The time between each “display event” generated by the bonus mode when its running. (In other words, this is essentially how long each bonus slide is show.) This can be overridden on a slide-by-slide basis.

hurry_up_delay_ms:

Time value, default 500ms

The time between each “display event” after the bonus “hurry up” mode has been triggered. So if the `display_delay_ms:` is 2 seconds, and then the player hits both flippers at the same time to “hurry up” the bonus display, that hurry up time will be used here.

Note that if you don’t want to show the slides faster, rather you just want to jump directly to the last slide, then you can enter a value of 0 here.

hurry_up_event:

Name of an event. Default is `flipper_cancel`.

The event that will cause the bonus mode to change its delay between slides from the `display_delay_ms:` time to the `hurry_up_delay_ms:` time. When this event is posted, the next slide is shown immediately, and the timing is set to the new hurry up value.

end_bonus_event:

Name of an event. Default is None.

If you enter an event name here, the bonus mode will pause before posting its *bonus_done* event and wait for this event to be posted. If this event is None, then the bonus mode will automatically end. You can enter an event name here if you have something custom you want to do in the bonus mode.

keep_multiplier:

Boolean True/False or Yes/No. Default is False.

Controls whether the `bonus_multiplier` player variable should be reset (to 1) when the bonus mode is over. Default is False which will not keep the bonus. (e.g. default is to reset it)

bonus_entries:

A list of sub-entries, with one entry for each “thing” you want to track in the bonus.

This is the real meat of the bonus section. Many modern pinball machines have lots of different things that go into the bonus calculation. So rather than just saying, “Your bonus is 5400 points”, it’s more

like “5 aliens x 25k points each, plus 15 modes x 1m each, plus 4 combos x 100k each, all times the bonus multiplier.”

Since this section is entered like a list, you need a dash and a space at the beginning of each new entry so MPF knows where one entry ends and one begins.

Here’s how an example might look based on the aliens, modes, and combos example just mentioned:

bonus_entries:

- event: alien_bonus score: 25000 player_score_entry: aliens
- event: mode_bonus score: 1000000 player_score_entry: num_modes
- event: combo_bonus score: 100000 player_score_entry: combos

Let’s look at each option you can use in each bonus entry:

event: (required)

The name of the event that is posted by the bonus mode. You should use a `slide_player:` in your bonus mode with slide entries based on these names, so when the bonus mode posts that event, you can show a slide with the relevant information for that bonus entry.

score: (required)

How many points this bonus entry is worth. Note that this will be multiplied by the `player_score_entry:` (if it’s present). Also note that you can use *dynamic values* here if you want to do advanced math.

player_score_entry:

An optional name of a player variable that will be multiplied by the `score:` entry. This is useful for the “easy” entries where it’s just “some player variable multiplied by some score”. (For example, “number of aliens times 25,000”.) In the example above, the first entry called “alien_bonus” will multiply the “aliens” player variable times 25000.

Note that the bonus mode doesn’t care what player variable you use, and it would be up to you to make sure that the player variable you choose is updated throughout your game (either through a `scoring:` section or a logic block or something like that).

Also if you choose not to include this entry, that’s fine. In that case the `score:` entry will be used by itself. Notice in the example at the top of this page from *Brooks ‘n Dunn* that it’s not used when we need the advanced math of multiplying two player variables together.

reset_player_score_entry:

Boolean (True/False or Yes/No). Default is False.

If this is true/yes, then the bonus mode will reset the `player_score_entry:` back to 0 once the bonus mode is over. This is just a convenience thing for simpler bonus calculations that need to be reset per ball. You don’t have to use it can could also reset the player variable some other way.

skip_if_zero:

Boolean (True/False or Yes/No). Default is True.

If this is True/Yes, then if the score calculation for this bonus entry turns out to be 0, then the event for this bonus entry is not posted. This is nice if you don't want a bonus screen to show up for something the player has not done, like "0 ramps = 0 points" or whatever. (Or maybe you want to make this "true" to show the player how bad they are?) :)

coil_overwrites:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The coil_overwrites: section of your config is where you...

Todo: Add description.

Optional settings

The following sections are optional in the coil_overwrites: section of your config. (If you don't include them, the default will be used).

hold_power:

Single value, type: int(0,8). Default: None

Todo: Add description.

pulse_ms:

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: None

Todo: Add description.

pulse_power:

Single value, type: int(0,8). Default: None

Todo: Add description.

recycle:

Single value, type: boolean (Yes/No or True/False). Default: None

Todo: Add description.

coil_player:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES
Valid in <i>shows</i>	YES

Note: This section can also be used in a show file in the coils: section of a step.

The coil_player: section of your config is where you configure coil/solenoid/driver actions (pulse, enable, disable, etc.) based on events. It's also used in shows (via the coils: section) to perform coil actions in that show step.

Example from a config file:

```
coil_player:
  some_event: coil_1
  some_other_event:
    coil_2:
      action: enable
      power: .5
```

In the example above, when the event called some_event is posted, coil_1 will pulse. When the event some_other_event is posted, coil_2 will enable (be held on) at power level 4.

Note that the some_event: coil_1 is entered in a different way than the some_other_event:. The first one has a simple key/value pair, whereas the second has a complete nested sub-configuration.

The first example shows the “express” config, while the second shows the full config. (What’s an “express config?” Details [here](#).)

The coil player’s express config is the “pulse” action.

Example coil player from a show:

```
- time: 0
  coils:
    coil1: pulse
```

Optional settings

The following sections are optional in the coil_player: section of your config. (If you don’t include them, the default will be used).

action:

Single value, type: string (case-insensitive). Options include pulse, enable, on, disable, or off.

Default: pulse

What action the coil should perform. Note that “on” and “enable” are the same, and that “disable” and “off” are the same.

power:

Single value, type: number (will be converted to floating point). Default: 1.0

A multiplier value that will be applied to this coil’s pulse time (which you can use to make this coil pulse for longer or shorter durations). Note that this power setting only applies to pulse actions.

pulse_ms:

The number of milliseconds you’d like this coil to pulse for. This setting overrides the coil’s default pulse_ms setting. Note that this setting only affects pulse actions.

coils:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The coils: section of your config is used to map coil (solenoid) names to driver board outputs. You can also set the default pulse times, set tags, and specify power levels for coils that get held on. This section *can* be used in your machine-wide config files. This section *cannot* be used in mode-specific config files. Here’s an example section:

```
coils:
  flipper_right_main:
    number: A0-B0-0
    pulse_ms: 30
    tags:
  flipper_right_hold:
    number: A0-B0-1
    tags:
  knocker:
    number: A0-B1-0
    pulse_ms: 20
    tags:
  pop_bumper_left:
    number: A0-B1-1
    pulse_ms: 18
    tags: ball_search
  ball_gate:
    number: A0-B1-2
```



```
hold_power: 3
tags: ball_search
```

The options are as follows:

Required settings

The following sections are required in the `coils:` section of your config:

<name>:

Each subsection of `coils:` is the name of the coil as you'd like to refer to it in your game code. This can really be anything you want, but it's obviously best to pick something that makes sense.

number:

Single value, type: string.

This is the number of the coil which specifies which driver output the coil is physically connected to. The exact format used here will depend on which control system you're using and how the coil is connected.

See the [How to configure "number:" settings](#) guide for details.

Optional settings

The following sections are optional in the `coils:` section of your config. (If you don't include them, the default will be used).

allow_enable:

Single value, type: boolean (Yes/No or True/False). Default: False

MPF will not enable any coil at 100% power unless you also add an `allow_enable: true` entry to that coils' settings. We include this as a safety precaution since many coils will burn up if you enable them on solid, so the fact that you have to explicitly allow this for a coil prevents you from screwing something up and accidentally enabling a coil that isn't supposed to be enabled. If you have a `hold_power:` setting less than 8 (full power), then you don't need this `allow_enable:` entry since you are implying you want to hold the coil by adding the `hold_power` setting. The default `hold_power` is 100%, so if you just want to be able to enable a coil at 100% then just add `allow_enable: true` and you don't have to add a `hold_power` entry. If you try to enable a coil that does not have `hold_power` configured or `allow_enabled` set to true, then the coil will not actually be enabled and you'll get a warning in your log file.

debug:

Single value, type: boolean (Yes/No or True/False). Default: False

See the [documentation on the debug setting](#) for details.

disable_events:

List of one or more events (with optional delay timings), in the *device control events* format.

Default: None (Note that if you add an entry here, it will replace the default. So if you also want the default value(s) to apply, add them too.)

Disables this coil (meaning that if it's active, it's shut off).

enable_events:

List of one or more events (with optional delay timings), in the *device control events* format.

Default: None (Note that if you add an entry here, it will replace the default. So if you also want the default value(s) to apply, add them too.)

Enables (holds on) this coil. This requires that *allow_enable* is true or that a *hold_power* setting is configured.

hold_power:

Single value, type: int(0,8). Default: None

This setting lets you control how much power is sent to the coil when it's "held" in the on position. This is an integer value from 0-8 which controls the relative power:

- 0: 0% power (e.g. "off")
- 1: 12.5%
- 2: 25%
- 3: 37.5%
- 4: 50%
- 5: 62.5%
- 6: 75%
- 7: 87.5%
- 8: 100% (see the "allow_enable" section below)

Different hardware platforms implement the hold power in different ways, so this 0-8 *hold_power* setting provides a generic interface that works with all hardware platforms. (You can also add platform- specific settings here for more fine-grained control of how the hold power is applied. See the How To guide for your specific hardware platform for details.) This *hold_power:* section is optional, and you only need it for coils you intend to hold on. In other words, if a coil is just pulsed (which is most of them), then you don't need to worry about this section.

label:

Single value, type: string. Default: %

A descriptive name for this device which will show up in the service menu and reports.

platform:

Single value, type: string. Default: None

Name of the platform this coil is connected to. The default value of None means the default hardware platform will be used. You only need to change this if you have multiple different hardware platforms in use and this coil is not connected to the default platform.

See the *Mixing-and-Matching hardware platforms* guide for details.

pulse_events:

List of one or more events (with optional delay timings), in the *device control events* format.

Default: None (Note that if you add an entry here, it will replace the default. So if you also want the default value(s) to apply, add them too.)

Event(s) that pulse this coil (at its default pulse_ms and power settings).

pulse_ms:

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: None

The default amount of time, in milliseconds, that this coil will pulse for. This can be overridden in other ways, but this is the default that will be used most of the time. Default is *10ms*, which is extremely weak, but set low for safety purposes.

pulse_power:

Single value, type: int(0-8). Default: None

The power factor which controls how much power is applied during the initial pulse phase of the coil's activation. (Note that not all hardware platforms support variable pulse power.) See the section on *hold_power*: above for details.

recycle:

Single value, type: boolean (Yes/No or True/False). Default: False

Controls whether this coil should add a small delay before it's allowed to be fired again. (This is used on things like pop bumpers and slingshots to prevent "machine gunning.")

This is a boolean setting because it's implemented differently depending on the hardware platform used. See the documentation for your specific hardware platform if you'd like more control than what's available with the straight on/off settings.

tags:

List of one (or more) values, each is a type: string. Default: None

Special / reserved tags for coils: *None*

See the [documentation on tags](#) for details.

color_correction_profiles:

TODO

combo_switches:

Config file section

Valid in machine config files	YES
Valid in mode config files	YES

New in version 0.32.

The `combo_switches:` section of your config is where you configure [combo switches](#) which are used for things like “flipper cancel” or super skill shots where the player holds in one flipper button while hitting the launch button.

Here’s an example machine config file using them:

```
#config_version=4

modes:
  - mode1

switches:
  switch1:
    number:
  switch2:
    number:
  switch3:
    number:
  switch4:
    number:
  switch5:
    number:
    tags: tag1
  switch6:
    number:
    tags: tag1
  switch7:
    number:
    tags: tag2
  switch8:
    number:
    tags: tag2
  switch9:
    number:
    tags: left_flipper
  switch10:
    number:
    tags: right_flipper
```



```

combo_switches:
  tag_combo:
    tag_1: tag1
    tag_2: tag2
  switch_combo:
    switches_1: switch1
    switches_2: switch2
  multiple_switch_combo:
    switches_1: switch1, switch2
    switches_2: switch3, switch4
  custom_offset:
    switches_1: switch1
    switches_2: switch2
    max_offset_time: 1s
  custom_hold:
    switches_1: switch1
    switches_2: switch2
    hold_time: 1s
  custom_release:
    switches_1: switch1
    switches_2: switch2
    release_time: 1s
  custom_times_multiple_switches:
    tag_1: tag1
    tag_2: tag2
    max_offset_time: 1s
    hold_time: 1s
    release_time: 1s
    debug: true
  custom_events:
    switches_1: switch1
    switches_2: switch2
    events_when_both: active_event, active_event2
    events_when_inactive: inactive_event
    events_when_one: one_event

```

To use combo switches, add a `combo_switches:` section to either a mode or machine config. Then create subsections for each combo you want to use. (A switch can be part of more than one combo.)

The name of each combo doesn't really matter, though it's used to construct the events that are posted by this combo unless you override them.

Note about switch and tag "groups"

MPF's combo switches are meant to be used in pairs of two. (We figure that players only have two hands, so it doesn't really make sense to do combos that require three buttons to be pushed at once. Though if you want that then you can write some custom code for it.)

Usually combos would just be two switches. `left_flipper + right_flipper` or `left_flipper + launch_button`. However to give the most flexibility, you can enter your switches using either tags or switch names. It doesn't matter which you use (and you can mix-and-match if you want), the main thing is for the combo to work, you need to have at least one switch in the "1" side and one switch on the "2" side.

Note that if you have more than one switch in either group (either by specifying multiple switches for the switch config, or by using a tag that's applied to multiple switches, or both), then the combo will become active when *any* switch from either group is active. (This can be useful if you have two-stage flipper buttons where a half-push of the button controls the bottom flipper and a full push controls the top flipper. In that case you technically have two switches per flipper button and you can add both to each group in your combo.)

Built-in flipper cancel combo

MPF's `mpfconfig.yaml` (the built-in machine config that's merged in with all machine configs) includes the following section:

```
combo_switches:
  both_flippers:
    tag_1: left_flipper
    tag_2: right_flipper
    events_when_both: flipper_cancel
```

This means if you tag add tags: `left_flipper` to your left flipper button and tags: `right_flipper` to your right flipper button, you'll get an event `flipper_cancel` posted anytime the player has both flipper buttons pushed in which you can use to cancel shows or whatever else you want to do. If you want to change or override this (perhaps you want to set a `max_offset_time`: to make sure this event is only posted if the player hits the flipper buttons within 500ms, then you can copy and add this section to your own machine config file and it will overwrite this default config.

Combo Settings

The following settings are used in the `combo_switches`: section of your config.

tag_1:

List of one (or more) names of tag names. Default: None.

A tag (or list of tags) of switches (in the `switches`: section of your machine config that will be used for switches for group 1 of the combo. You can either use a tag, or use the `switches_1`: setting (or both, really).

tag_2:

List of one (or more) names of tag names. Default: None.

A tag (or list of tags) of switches (in the `switches`: section of your machine config that will be used for switches for group 2 of the combo. You can either use a tag, or use the `switches_2`: setting (or both).

switches_1:

List of one (or more) names of switch names. Default: None.

A switch name (or a list of switches) that will be used for the group 1 of the combo. You can use this setting or the `tag_1`: setting above.

switches_2:

List of one (or more) names of switch names. Default: None.

A switch name (or a list of switches) that will be used for the group 1 of the combo. You can use this setting or the tag_2: setting above.

max_offset_time:

Single value, type: time string (secs) (*Instructions for entering time strings*). Default: -1

Specifies a time window that a switch from group 1 and group 2 have to be hit within in order to register as a combo.

The default value of -1 means there is no time limit, meaning that the player can hit and hold one button, and then five minutes later hit the next button, and the combo will count.

If you set max_offset_time: 1s, that means that the player will have to hit (and hold) both switches within 1 second of each other.

hold_time:

Single value, type: time string (ms) (*Instructions for entering time strings*). Default: 0

How long each button has to be pressed in order for it to count as a combo. The default is 0 which means that as soon as both switches are active, the combo is active.

If you set hold_time: 1s, that means that the player will have to press and hold both buttons for 1 second before the combo's "both" event is posted.

release_time:

Single value, type: time string (ms) (*Instructions for entering time strings*). Default: 0

How long a button has to be released before the combo will switch from "both" state to the "one" state. The default is 0 which means this is instant.

Note that once both buttons are released, the combo is cleared. This setting only affects the scenario when one button is held in while the other is released.

events_when_both:

List of one (or more) names of events. Default: None.

This is an event (or a list of events) that will be posted when both switches are held in. If you have a max_offset_time: configured, then both switches will need to have been pressed within that time. If you have a hold_time: configured, then both switches will need to be active for at least that long before this event (or these events) are posted.

If the player pushes both switches, then releases one, then pushes in the switch that was released again, this event will be re-posted.

If you don't set this value, then a default event with the name of your combo plus _both will be used.

events_when_one:

List of one (or more) names of events. Default: None.

This is an event (or list of events) that will be posted when the player releases one switch after both switches have been pressed together. (In other words, this event will only be posted after the events_when_both event is posted.)

If you don't set this value, then a default event with the name of your combo plus _one will be used.

events_when_inactive:

List of one (or more) names of events. Default: None.

This is an event (or list of events) that will be posted when the player releases both of the buttons, essentially “releasing” the combo.

If you don't set this value, then a default event with the name of your combo plus _inactive will be used.

config:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES

Changed in version 0.31: (Now valid in mode configs too.)

The config: section of your configuration files allows you to specify *additional* configuration files that will be read in after the current file is loaded. Here's an example:

```
config:
  - machine.yaml
  - devices.yaml
  - game.yaml
  - textstrings.yaml
  - keymap.yaml
```

Note that each file is on its own line, which starts with a minus, then a space, then the file. (The space is important.) Also note that you can (optionally) specify a path, like this:

```
- config\machine.yaml
- config/my_game/machine.yaml
```

MPF will attempt to convert relative and absolute paths based on your OS, and it can deal with slashes in either direction.

MPF will then open those files one-by-one and merge their settings into the master configuration dictionary. The settings are merged together in the order the files are listed, so if multiple files specify the same configuration option then whichever one comes later in the list will overwrite any options that have already been specified.

You can also have `config:` sections in other config files, meaning that one config file can call another which will call another, etc.

Whenever MPF encounters a new config file, it will add it to the end of the list. And since files are processed in order, if there are any conflicting settings then the last file on the list will “win.” Also note that the framework will attempt to load the file from the current working directory (containing the config file that `config:` entry is from. If that fails then it will try the last known good directory that worked for a config file.

credits:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The `credits:` section of your config contains settings for the credits mode.

There’s a full How To guide which walks you through setting up the credits mode, so be sure to read that for the details. This page just contains the settings which control how the credits mode behaves. Here’s an example config:

```
credits:
  max_credits: 12
  free_play: no
  price_tier_template: "{{credits}} CREDITS ${price}"
  service_credits_switch: s_esc
  switches:
    - switch: s_left_coin
      type: dollars
      value: .25
    - switch: s_right_coin
      type: dollars
      value: 1
  pricing_tiers:
    - price: .50
      credits: 1
    - price: 2
      credits: 5
  events:
    - event: special
      type: special
      credits: 1
    - event: replay
      type: replay
      credits: 1
    - event: high_score_credit
      type: high_score
      credits: 1
    - event: match
      type: match
      credits: 1
  fractional_credit_expiration_time: 15m
  credit_expiration_time: 2h
```



```
persist_credits_while_off_time: 1h
free_play_string: FREE PLAY
credits_string: CREDITS
```

Optional settings

The following sections are optional in the `credits:` section of your config. (If you don't include them, the default will be used).

`credit_expiration_time:`

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: 0

The amount of time before any credits on the machine are removed (resetting the number of credits back to 0). This timer only runs while the machine is in attract mode, and its reset each time a new credit (or partial credit) is added to the machine. If a game is played, the timer starts fresh when the game is over and the machine goes back to attract mode. This value is entered as a standard MPF time string and can be minutes, hours, or even days long. Default is *2 hours*.

`credits_string:`

Single value, type: string. Default: CREDITS

This is the text that will make up the `credits_string` before the number of credits. For example, if there are 2 1/2 credits on the machine, the `credits_string` will be *CREDITS 2 1/2*. Default is *CREDITS*.

`fractional_credit_expiration_time:`

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: 0

The amount of time before fractions of credits are removed from the machine. This doesn't affect whole credits, so if the machine is sitting there with 2 1/4 credits on it, after this time expires MPF will clear the 1/4 credit leaving 2 whole credits. This timer only runs while the machine is in attract mode, and its reset each time a new credit (or partial credit) is added to the machine. If a game is played, the timer starts fresh when the game is over and the machine goes back to attract mode. This value is entered as a standard MPF time string and can be minutes, hours, or even days long. Default is *15 minutes*.

`free_play:`

Single value, type: boolean (Yes/No or True/False). Default: yes

Controls whether the machine is in free play mode. Note that if you want your machine to always be in free play mode, then you can also choose to not use the credits mode altogether.

free_play_string:

Single value, type: string. Default: FREE PLAY

The text string that will be used in the credits_string machine variable when the machine is in free play. Default is *FREE PLAY*.

max_credits:

Single value, type: integer. Default: 0

The maximum number of credits you want to allow on the machine. Note that pinball machines can't prevent players from adding money to machines, so be careful with this.

Note: This is a template setting

persist_credits_while_off_time:

Single value, type: time string (secs) (*Instructions for entering time strings*) . Default: 1h

The amount of time that credits will remain on the machine even when MPF is not running. Set to 0 if you do not want to MPF to retain credits when its powered off. The way this works behind the scenes is that whenever a new credit (or a fraction of a credit) is added to the machine, MPF writes that to disk as a persistent machine variable with an expiration time and date based on the current time plus the delay time you add here. When MPF boots up, it loads the credits from the machine variables file and checks their expiration time, and if it's in the past then it doesn't add them back. This value is entered as a standard MPF time string and can be minutes, hours, or even days long. Default is *1 hour*.

service_credits_switch:

List of one (or more) values, each is a type: string name of a switches: device. Default: None

This is the name of a switch that's used to add so-called "service credits" to the machine. This switch has a 1-to-1 ratio, meaning that one credit is added to the machine each time this switch is pressed.

switches:

The switches: section contains the following nested sub-settings.

A list of switches that, when triggered, add credits (or fractions of a credit) to the machine. Notice that the sub-entries under switches are actually a list with the settings for *switch*, *type*, and *value*, repeated multiple times.

Optional settings

The following sections are optional in the switches: section of your config. (If you don't include them, the default will be used).

switch:

Single value, type: string name of a switches: device. Default: None

The name of the switch (from your machine-wide *switches:* section) for the credit switch.

type:

Single value, type: string. Default: money

What type of currency is being deposited when that switch is hit. This doesn't affect the actual behavior of MPF, rather it's just used in as the column name and for totaling the earnings reports (so you can track "money" separate from "tokens"). You can enter whatever you want here: *money*, *dollars*, *dinars*, etc.

value:

Single value, type: number (will be converted to floating point). Default: 0.25

How much value is added whenever this switch is hit. Notice that there are no currency symbols here or anything. A value of .25 could be 0.25 dollars or 0.25 Euros or 0.25 Francs—it really doesn't matter. The key is that it's 0.25 of whatever monetary system you have.

price_tier_template

New in version 0.33.14.

Default "{credits}} CREDITS \${price}}"

TODO

pricing_tiers:

The *pricing_tiers:* section contains the following nested sub-settings.

This is where you actually set your pricing by mapping how many of your monetary units you want to equate to a certain number of credits. The default config is fairly common, with 0.50 currency resulting in 1 credit, with a price break at 2 that gives the player 5 credits instead of 4. (So basically they get one free credit if they put in enough money for 4 credits.) The most important thing to know here is that MPF always requires that 1 credit is used to start a game, and 1 credit is required to add an additional player to a game. So if you want to change the price of your game, you don't change the number of credits per game, rather, you change the number of credits a certain amount of money is worth. The pricing tier discount processing is reset when Ball 2 starts. So if it costs \$0.50 for one credit or \$2 for 5 credits, if the player puts \$0.50 in the machine and plays a game, if they wait until that game is over and deposit another \$1.50, they'll only get 3 more credits. You can have as many *pricing_tiers* as you want. The first one dictates how much a regular game costs and is required. If you don't want any price breaks, then just add the first one.

Here's an example:


```
pricing_tiers:
- price: .50
  credits: 1
- price: 2
  credits: 5
```

Optional settings

The following sections are optional in the `pricing_tiers:` section of your config. (If you don't include them, the default will be used).

credits:

Single value, type: integer. Default: 1

The total number of credits that will be added based on this price tier

price:

Single value, type: number (will be converted to floating point). Default: .50

The numeric currency value for this pricing tier.

events:

New in version 0.33.12.

A list of one or more events with settings which add credits based on MPF events. Like the `pricing_tiers` section, start each entry here with a minus sign and a space.

```
events:
- event: special
  type: special
  credits: 1
- event: replay
  type: replay
  credits: 1
- event: high_score_credit
  type: high_score
  credits: 1
- event: match
  type: match
  credits: 1
```

event:

The event that will trigger a credit action.

type:

String which can be whatever you want, used for audits. This lets you track different types of credits, for example, money in versus replays versus specials versus high score awards, etc.

award:

Numeric value of the number of credits you'd like to award.

displays:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The displays: section of your config is where you configure the logical displays in your machine. A display is used to show slides, and can be an on-screen window or a DMD.

You can have more than one display. For example, if you want to have a DMD and also display an on-screen window, you'll actually have two displays:, the DMD is one and the on-screen window is the other.

Here's an example displays: section from *Demo Man* with two displays:

```
displays:
  window:
    height: 200
    width: 600
  dmd:
    width: 128
    height: 32
    default: true
```

In the example above, one of the displays is called *window* and the other is called *dmd*. Note that the names here are completely arbitrary. Just naming a display "window" does not make it show up in the window, and naming a display "dmd" doesn't make it show up in the DMD. (When you configure your window in the window: section of your config, you specify the name of the display you want to be the *source* for the window content. Same for the DMD.)

The names of the displays are used as "targets" for your slides. So when you show a slide, you specify which display you want it to show on. If you don't specify a target, it will choose the default. If you only have one display, you never have to worry about this because that display will always be the default. If you have more than one, you can add the `default: true` to a display here to tell MPF which display is your default which is used when you play slides without specifying a target.

Note: Starting in MPF v0.33, If you do not put a displays: section in your machine config, MPF will automatically create a single display called "default" with a size of 800x600. (This matches the default window size.)

Each display in your displays: section can have the following settings:

Optional settings

The following sections are optional in the `displays:` section of your config. (If you don't include them, the default will be used).

default:

Single value, type: boolean (Yes/No or True/False). Default: False

Specifies that this display is the default, meaning it's the display that's used if you show a slide without specifying a target for that slide. If you only have one display, it will be the default automatically.

height:

Single value, type: integer. Default: 600

The height of the display, in pixels. Note that if you're showing this display on the screen, you can scale the screen window which will scale the display. So the height here can be thought of as the "native" height of the display.

width:

Single value, type: integer. Default: 800

The width of the display, in pixels.

diverters:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

You create and configure your diverters in the `diverters:` section of your machine configuration file. Here's an example from *Star Trek: The Next Generation*:

```
diverters:
  top_diverter:
    activation_coil: c_top_divertor # WMS uses the -tor spelling
    type: hold
    activation_time: 3s
    activation_switches: s_enter_left_ramp
    enable_events: ball_started
    disable_events: ball_ended, borg_lock_Lit
    targets_when_active: playfield
    targets_when_inactive: bd_borg_ship
  subway_top_diverter:
    activation_coil: c_under_divertor_top
    type: hold
    activation_time: 3s
```



```

    activation_switches: s_underTopHole, s_underLeftHole, s_underBorgHole
    targets_when_active: bd_rightCannonVUK
    targets_when_inactive: bd_leftVUK
    feeder_devices: bd_catapult
subway_bottom_diverter:
    activation_coil: c_underDiverterBottom
    type: hold
    activation_time: 3s
    activation_switches: s_under_top_hole, s_under_ueft_hole, s_under_borg_hole
    targets_when_active: bd_left_cannon_vuk
    targets_when_inactive: bd_left_vuk
    feeder_devices: bd_catapult
drop_target:
    activation_coil: c_top_drop_down
    deactivation_coil: c_top_drop_up
    type: pulse
    targets_when_active: bd_left_cannon_vuk, bd_right_cannon_vuk, bd_left_vuk
    targets_when_inactive: playfield
    feeder_devices: bd_catapult

```

Understanding the difference between “enabling” and “activating” diverters

When talking about diverters in MPF, we use the terms *activate* and *enable* (as well as *deactivate* and *disable*). Even though these words sound like they’re the same thing, they’re actually different, so it’s important to understand them.

When a diverter is *active*, that means it’s physically activated in its active position. A diverter that is *enabled* means that it’s ready to be activated, but it’s not necessarily active at this time. To understand this, let’s step through an example.

Imagine a typical ramp in a pinball machine which has one entrance and two exits. These kinds of ramps usually have a diverter at the top of them that can send the ball down one of the two paths. When the diverter is *inactive* (its default state), the ball goes down one path, and when the diverter is *active*, the ball is sent down the other path (perhaps towards a ball lock).

There is typically an entrance switch on the ramp which lets the game know that a ball is potentially headed towards that diverter, so when the game wants to route the ball to the “other” ramp exit, rather than turning on that diverter and holding it on forever, the game just watches for that ramp entry switch and then quickly fires the diverter to route the ball to the other exit. Then once the ball passes by the diverter, it hits a second switch which turns off the diverter. (Typically the diverter activation also has a timeout which is used when a weak shot is made where the ball trips the ramp entrance switch but doesn’t actually make it all the way up the ramp to the diverter.)

So in MPF parlance, we say that the diverter is *enabled* whenever it’s ready to be fired, but it’s not actually *active* until the coil is physically on.

Again using our example, let’s say we have a ramp with a diverter, and when that diverter is *active* it sends a ball into a lock. When the game starts, the diverter is *disabled* and *inactive*. Ramp shots just go up the ramp and come out the default path, and the diverter ignores the ramp entrance switch.

Then when the player does whatever they need to do to light the lock, the diverter is *enabled*. At this point the diverter is *not* active since it’s not actually firing, but it’s *enabled* (which means it’s ready to fire) and the diverter is watching that ramp entrance switch. (So the diverter is *enabled* but *inactive*.)

Then when the player shoots the ball up that ramp, the diverter sees the ramp entrance switch hit and the diverter activates. (So now the diverter is *enabled* and *active*.)

Then once the ball passes by the diverter, the diverter deactivates. At this point whether the diverter is disabled or enabled depends on the game logic. If the lock should stay lit, then the diverter remains enabled even though it's not *active*, and if the player has to do something else to re-light the lock, then the diverter is *disabled* and *inactive*.

Hopefully that makes sense? :)

<diverter name>

Create a subentry in your *diverters:* section for each diverter you want to create. (Remember that you should create anything that's activated to change the path of the ball as a diverter, including traditional diverters, up/down posts, coil-controlled gates, playfield trap doors, and controlled drop targets which block entrances to devices.)

Optional settings

The following sections are optional in the *diverters:* section of your config. (If you don't include them, the default will be used).

activate_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, cause this diverter to activate.

activation_coil:

Single value, type: string name of a coils: device. Default: None

The name of the coil that is used to activate your diverter.

activation_switches:

List of one (or more) values, each is a type: string name of a switches: device. Default: None

A list of one or more switches that trigger the diverter to activate. This switch only activates the diverter if the diverter has been enabled (either manually or via one of the *enable_events*. If you have an activation switch, MPF writes a hardware autofire coil rule to the pinball controller which fires the diverter automatically when the *activation_switch* is hit. This is done so the diverter will have instantaneous response time, needed to get the diverter to fire in time to catch a fast-moving ball.

activation_time:

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: 0

This is how long the diverter stays active once it's been activated. A value of zero (or omitting this setting) means this diverter does not timeout, and it will stay active until it's disabled or you manually deactivate it.

deactivate_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the *Device Control Events* documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, cause this diverter to deactivate.

deactivation_coil:

Single value, type: string name of a coils: device. Default: None

The name of the coil that's used to deactivate your diverter. You only need to specify this coil if it's a different coil from from *activation_coil*. (In other words this is only used with diverters that have two coils.)

An example of this is when a drop target is used to block the entrance of a ball device. (For example, the drop target under the saucer in *Attack from Mars*, the drop target to the left of the upper lanes in *Star Trek: The Next Generation*, or the middle letter "D" drop target in *Judge Dredd*.) Each of these has one coil to "knock down" the drop target and a second coil to "reset" the drop target.

By the way, if you have two coils to control a diverter, it doesn't really matter which one is the *activation_coil* and which is the *deactivation_coil*. Just know that after the *activation_coil* is fired, MPF will consider that diverter to be in the active state, and once the *deactivation_coil* is fired, MPF will consider that diverter to be in the inactive state, and set up your targets accordingly.

deactivation_switches:

List of one (or more) values, each is a type: string name of a switches: device. Default: None

A list of one or more switches that will deactivate a diverter. (For example, this might be a switch that's "after" the diverter in a subway, so once this switch is activated then MPF knows the ball made it through the diverter and it can deactivate it.)

debug:

Single value, type: boolean (Yes/No or True/False). Default: False

Todo: Add description.

disable_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the *Device Control Events* documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, disable this diverter. Typically it's *ball_ending* (which is posted when a ball is in the process of ending), meaning this diverter will not be enabled when the next ball is started. You might also set a disable event to occur based on the event posted from a mode ending.

disable_switches:

List of one (or more) values, each is a type: string name of a switches: device. Default: None

A list of one more more switches that will automatically disable this diverter. It's optional, since the diverter will also be disabled based on one of your *disable_events* being posted.

enable_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the *Device Control Events* documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, enable this diverter. (Remember that enabling a diverter is not the same as activating it.)

feeder_devices:

List of one (or more) values, each is a type: string name of a ball_devices: device. Default: playfield

This is a list of one or more ball devices that can eject balls which have the option of being sent to this diverter. This is an important part of the diverter's ability to automatically route balls to the devices they go to.

When you configure a *feeder_device*: setting for a diverter, it causes the diverter to watch for balls ejecting from that device. Every ball that's ejected in MPF has a "target" (either a ball device or the playfield), so when a diverter's feeder device ejects a ball, the diverter will see what the eject target is, and if that target is included in the diverter's list of *targets_when_active* or *targets_when_inactive*, then the diverter will activate or deactivate itself to make sure the balls gets to where it needs to go.

label:

Single value, type: string. Default: %

Todo: Add description.

reset_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: machine_reset_phase_3

Todo: Add description.

tags:

List of one (or more) values, each is a type: string. Default: None

Todo: Add description.

targets_when_active:

List of one (or more) values, each is a type: string name of a ball_devices: device. Default: playfield

This is a list of *all* ball devices that can be reached by a ball passing through this diverter when it's active. Valid options include the names of ball devices and the word "playfield."

This setting exists because diverters in MPF can be configured so that they automatically activate or deactivate when one of their target devices wants a ball. For example, if you have a diverter on a ramp that will route a ball to a lock when its active, you can add the name of that ball device here. Then if that device ever needs a ball, the diverter will automatically activate to send a ball there. This greatly simplifies programming, because all you have to do is essentially say, "I want this device to have a ball," and MPF will make sure the diverter sets itself appropriately to get a ball to that device.

Let's look at the diverter configuration from *Star Trek: The Next Generation* included at the top of this section for an example. In the settings for the *dropTarget* diverter, notice that there are three items in the *targets_when_active*: list: *bd_leftCannonVUK*, *bd_rightCannonVUK*, and *bd_leftVUK*. This means that when this diverter is active, balls passing through it are able to reach any one of those three ball devices. Note that this particular diverter doesn't exactly know how the ball gets to any of those devices—that's actually handled via additional downstream diverters (*subwayTopDiverter* and *subwayBottomDiverter*). All the *dropTarget* diverter needs to know is, "If a ball needs to go to one of these three diverters, then I better be active."

targets_when_inactive:

List of one (or more) values, each is a type: string name of a ball_devices: device. Default: playfield

This is exactly like the *target_when_active*:*above, except it represents the target devices that a ball can reach when this diverter is disabled. Looking at the same **dropTarget* diverter example from above, we see that when the *dropTarget* is inactive, the ball is routed to the playfield.

type:

Single value, type: one of the following options: hold, pulse. Default: hold

Specifies how the *activation_coil* should be activated. You have two options here:

- pulse - MPF will pulse the coil to activate the diverter.
- hold - MPF should hold the diverter coil in a constant state of “on” when the diverter is active. Note that if the coil is configured with a *hold_power*, then it will use that pwm pattern to hold the coil on. If no *hold_power* is configured, then MPF will use a continuous enable to hold the coil. (In this case you would need to add *allow_enable: true* to that coil’s configuration in the *coils*: section of your machine configuration file.)

ball_search_order:

Numeric value, default is 100

New in version 0.33.

A relative value which controls the order individual devices are pulsed when ball search is running. Lower numbers are checked first. Set to 0 if you do not want this device to be included in the ball search. See the [Ball Search](#) documentation for details.

ball_search_hold_time:

Single value, type: time string ([Instructions for entering time strings](#)) . Default: 1s

New in version 0.33.

How long this diverter will be activated for when it is activated during ball search.

playfield:

New in version 0.33.

The name of the playfield that this diverter is on. The default setting is “playfield”, so you only have to change this value if you have more than one playfield and you’re managing them separately. s

drop_target_banks:

Config file section

Valid in machine config files	YES
Valid in mode config files	YES

Once you’ve configured your individual drop targets, you group them together into banks via the *drop_target_banks*: section of your config file. Here’s an example from *Judge Dredd*:


```
drop_target_banks:
  judge:
    drop_targets: j, u, d, g, e
    reset_coils: c_reset_drop_targets
    reset_on_complete: 1s
```

What about drop target banks with lights?

Notice there are no settings to control lights associated with drop targets, but many machines (like *Judge Dredd* used in the example) have lights for each drop target. To control those lights, you'd create shots based on the lights and switches for each drop target, and then you control them just like any other shot with the shot settings, shot_group settings, and shot profiles. In this case you'd end up specifying your switch for this drop target as well as for a shot for it. It's ok to have the same switch in both places.

Required settings

The following sections are required in the drop_target_banks: section of your config:

<name>:

Create a subsection under *drop_target_banks*: for each bank of drop targets you have. The name of each section is the name you'll refer to the drop target as in your game code. ("judge", in this example.)

drop_targets:

List of one (or more) values, each is a type: string name of a drop_targets: device.

A list of the names of the individual drop targets (from the names you chose in the *drop_targets*: section of your config file) that are included in this bank. Note that single drop target devices can be members of multiple banks at the same time. For example, you might have two banks of three drop targets, from which you could actually actually three drop target banks. One for the first three, one for the second three, and one for all six. Then you could track separate up and down events for a subset of three or for all six getting knocked down.

Optional settings

The following sections are optional in the drop_target_banks: section of your config. (If you don't include them, the default will be used).

debug:

Single value, type: boolean (Yes/No or True/False). Default: False

See the [documentation on the debug setting](#) for details.

label:

Single value, type: string. Default: %

A descriptive name for this device which will show up in the service menu and reports.

reset_coil:

Single value, type: string name of a coils: device. Default: None

The name of the coil that is fired to reset this bank of drop targets.

reset_coils:

List of one (or more) values, each is a type: string name of a coils: device. Default: None

If your drop target bank has two reset coils (as was common in older machines which huge banks of drop targets), you can add a *reset_coils* section (plural) and then specific a list of multiple coils. In this case, MPF will pulse all the coils at the same time to reset the bank of drop targets.

reset_on_complete:

Time value. Default: None

New in version 0.32.

By default, when a drop target bank completes, it does not automatically reset. If you want it to reset, then use this setting along with a time delay for when you want it to reset after it completes.

For example:

```
reset_on_complete: 500ms
```

reset_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: machine_reset_phase_3, ball_starting

Resets this drop target bank by pulsing this bank's *reset_coil* or *reset_coils*.

tags:

List of one (or more) values, each is a type: string. Default: None

Special / reserved tags for drop target banks: *None*

See the [documentation on tags](#) for details.

drop_targets:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

You configure individual *drop targets* in your machine in the `drop_targets:` section of your machine config file. (This section is only used for individual targets. Once you configure them here, then you group them into banks in the `drop_target_banks:` section.) Here's an example from *Judge Dredd*, with five drop targets we've given names *J*, *U*, *D*, *G*, and *E*.

```
drop_targets:
  j:
    switch: drop_target_j
    reset_coil: reset_drop_targets
  u:
    switch: drop_target_u
    reset_coil: reset_drop_targets
  d:
    switch: drop_target_d
    reset_coil: reset_drop_targets
    knockdown_coil: trip_drop_target_d
  g:
    switch: drop_target_g
    reset_coil: reset_drop_targets
  e:
    switch: drop_target_e
    reset_coil: reset_drop_targets
```

Important: Not all “drop targets” in your machine will be configured as “drop targets.” Some machines have drop target mechanisms that actually act as diverters. For example, in *Attack From Mars*, the drop target under the saucer is actually a diverter. When it's up, the ball stays on the playfield. When it's down, the ball enters the lock. *Star Trek: The Next Generation* has this with the drop target up above the lanes, and *The Wizard of Oz* has this for the drop target in front of the Winkie Guard. If a drop target in your machine is guarding a path to somewhere the ball can go, it might be a diverter. Of course sometime a drop target can be both, like the “D” target in *Judge Dredd*. Feel free to post to the forum with questions.

What about drop targets with lights?

Notice there are no settings to control lights associated with drop targets, but many machines (like *Judge Dredd* used in the example) have lights for each drop target. To control those lights, you'd create shots based on the lights and switches for each drop target, and then you control them just like any other shot with the *shot* settings, *shot_group* settings, and *shot profiles*. In this case you'd end up specifying your switch for this drop target as well as for a shot for it. It's okay to have the same switch in both places.

Required settings

The following sections are required in the `drop_targets:` section of your config:

<name>:

Create one entry in your *drop_targets:* section for each drop target in your machine. Don't worry about grouping drop targets into banks here. (That's done in the *drop_target_banks:* section.) The drop target name can be whatever you want, and it will be the name for this drop target which is used throughout your machine.

switch:

Single value, type: string name of a switches: device.

The name of the switch that's activated when this drop target is down. (Note that active switch = target down, so if your drop target uses opto switches which are reversed, then you need to configure this switch with *type: NC* in the *switches:* section of your config file.) MPF will automatically update the state of the drop target whenever the switch changes state.

Optional settings

The following sections are optional in the *drop_targets:* section of your config. (If you don't include them, the default will be used).

ball_search_order:

Single value, type: integer. Default: 100

A relative value which controls the order individual devices are pulsed when ball search is running. Lower numbers are checked first. Set to 0 if you do not want this device to be included in the ball search. See the [Ball Search](#) documentation for details.

ignore_switch_ms:

New in version 0.33.

How long this device should ignore switch changes while ball search is running. (Otherwise the ball search pulsing coils will set switches that could add to the score, start modes, etc. Default is 500ms.

debug:

Single value, type: boolean (Yes/No or True/False). Default: False

See the [documentation on the debug setting](#) for details.

knockdown_coil:

Single value, type: string name of a coils: device. Default: None

This is an optional coil that's used to knock down a drop target. Most drop targets do not have these. (In the *Judge Dredd* example above, you'll notice that only the *D* target has a knockdown coil.

knockdown_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, pulse this drop target's knockdown coil. (If this drop target doesn't have a knockdown coil, then these events will have no effect.)

enable_keep_up_events:

New in version 0.33.

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, will send enable the drop target's reset coil which means that balls that hit it do not cause the drop target to fall since the reset coil is being held on. Not that this will require either `allow_enable: true` in the coil's configuration or a `hold_power:` of less than 8 (full power).

Also note that many drop target coils are not designed to be held on at full power, so you'll most likely want to use a hold power of less than 8. Start low and only use the minimum power you need to keep the drop target up.

disable_keep_up_events:

New in version 0.33.

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, will send a "disable" command to the drop target's reset coil, disabling the "keep up".

label:

Single value, type: string. Default: %

A descriptive name for this device which will show up in the service menu and reports.

reset_coil:

Single value, type: string name of a coils: device. Default: None

The name of the coil that is pulsed to reset this drop target. The pulse time will be whatever you configure as the default pulse time for this coil in the `coils:` section of your machine configuration file. Important: Only enter a `reset_coil` name here if this coil is only resets this drop target. For banks of

drop targets where a single coil resets the entire bank of targets, enter the *reset_coil* in the *drop_target_banks*: configuration, not here. Why? Because if you have three drop targets in a bank, you only want to pulse the coil once to reset all the drop targets. If you enter the coil three times (one for each drop target), then it will pulse three times when the bank is reset.

reset_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: *ball_starting*, *machine_reset_phase_3*

Resets this drop target. If this drop target is not part of a drop target bank, then resetting this target will pulse its reset coil. If this drop target is part of a drop target bank, then resetting this drop target will have no effect. (Instead you would reset the bank.) Default is *ball_starting*, *machine_reset_phase_3*.

tags:

List of one (or more) values, each is a type: string. Default: None

Special / reserved tags for drop targets: *None*

See the [documentation on tags](#) for details.

playfield:

New in version 0.32.

The name of the playfield that this autofire device is on. The default setting is “playfield”, so you only have to change this value if you have more than one playfield and you’re managing them separately.

dual_wound_coils:

Config file section

Valid in machine config files	YES
Valid in mode config files	NO

The *dual_wound_coils*: section of your config is where you configure dual-wound coils that are added to your “coils” device list which can be used anywhere in MPF.

Here’s an example:

```
coils:
  c_hold:
    number:
    allow_enable: True
  c_power:
    number:
    pulse_ms: 20
```



```
switches:
  s_eos:
    number:

dual_wound_coils:
  c_dual_wound:
    hold_coil: c_hold
    main_coil: c_power
    eos_switch: s_eos
```

In the configuration above, a new coil called `c_dual_wound` is created that, when enabled, would energize both the `c_hold` and `c_power` coils. Then when the `s_eos` switch is activated, the `c_power` coil would be de-energized, leaving just the `c_hold` coil active until the `c_dual_wound` coil is deactivated.

Required settings

The following sections are required in the `dual_wound_coils:` section of your config:

<name>:

Create a sub-entry in your `dual_wound_coils:` section for each dual-wound coil you want to define.

Note: Dual-wound flipper coils are configured in the `flippers:` section of the config, so you don't have to define them here. Other dual-wound coils (like for diverters, etc.) should be defined here since other MPF devices do not have explicit support for dual-wound coils.

hold_coil:

Single value, type: string name of a coils: device.

The name of the hold coil winding. This coil must be a valid coil defined in your `coils:` section.

main_coil:

Single value, type: string name of a coils: device.

The name of the main (power) coil winding. This coil must be a valid coil defined in your `coils:` section.

When this dual-wound coils is enabled, this coil will be pulsed for the number of milliseconds specified in the original coil's `pulse_ms:` setting.

Optional settings

The following sections are optional in the `dual_wound_coils:` section of your config. (If you don't include them, the default will be used).

debug:

Single value, type: boolean (Yes/No or True/False). Default: False

See the [documentation on the debug setting](#) for details.

eos_switch:

Single value, type: string name of a switches: device. Default: None

The name of a switch which, when activated, will disable the power to the main coil winding.

Todo: Verify whether this has been implemented?

label:

Single value, type: string. Default: %

A descriptive name for this device which will show up in the service menu and reports.

tags:

List of one (or more) values, each is a type: string. Default: None

Special / reserved tags for dual-wound coils: *None*

See the [documentation on tags](#) for details.

event_player:

Config file section

Valid in machine config files	YES
Valid in mode config files	YES
Valid in shows	YES

Note: This section can also be used in a show file in the events: section of a step.

You can use the event_player: section of your config files to cause additional events to be automatically posted when a specific event is posted. The event_player can be thought of as a really simple way to implement game logic. (e.g. "When this happens, do this.")

If you add this section to your machine-wide config file, the entries here will always be active. If you enter it into a mode-specific config file, entries will only be active while that mode is active. Here's an example:


```

event_player:
  ball_starting:
    cmd_flippers_enable
    cmd_autofire_coils_enable
    cmd_drop_targets_reset
  ball_ending:
    cmd_flippers_disable
    cmd_autofire_coils_disable
  tilt:
    cmd_flippers_disable
    cmd_autofire_coils_disable
  slam_tilt:
    cmd_flippers_disable
    cmd_autofire_coils_disable

```

The event player settings above will post the events *cmd_flippers_enable*, *cmd_autofire_coils_enable*, and *cmd_drop_targets_reset* when the *ball_starting* event is posted. Similarly they will post events to disable the flippers and autofire coils when ball end and tilt events are posted.

To use this, simply create an *event_player:* entry in your config file. Then create sub- entries for each event you want to trigger other events, and add a list of one or more events that should be posted automatically under each trigger event.

Remember that you can create this *event_player:* section in either your machine-wide or in mode-specific config files. For example, if you want a target called “upper” to reset when a mode called “shoot_here” starts, you could create an entry like this in the shoot here mode’s *shoot_here.yaml* mode configuration file:

```

event_player:
  mode_shoot_here_started:
    cmd_upper_target_reset

```

extra_balls:

Config file section

Valid in <i>machine config files</i>	NO
Valid in <i>mode config files</i>	YES

The *extra_balls:* section of your config is where you configure which events trigger and reset extra ball awards.

Note that this extra ball abstract device is fairly basic right now. For example, there’s no good way to tie this into extra ball “lit” shots or anything at the moment.

Here’s an example:

```

extra_balls:
  my_mode_eb:
    award_events: alien_smashed
    reset_events: wizard_done

```

In the above example, the extra ball called *my_mode_eb* will be given to the player when the event *alien_smashed* is posted. After that, future *alien_smashed* events will not lead to additional extra balls.

(The `my_mode_eb` extra ball is “used up”, in a sense. However, if the event `wizard_done` is posted, then that would reset this extra ball and it could be awarded again. (This is very rare, since you don’t want a good player getting the same extra ball over and over.)

This is all tracked per-player in a player variable dictionary called “`extra_balls_awarded`”

Required settings

The following sections are required in the `extra_balls:` section of your config:

<name>:

Each subsection of `extra_balls:` is a name entry for a particular extra ball award.

Optional settings

The following sections are optional in the `extra_balls:` section of your config. (If you don’t include them, the default will be used).

`award_events:`

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, award this extra ball to the current player.

`debug:`

Single value, type: boolean (Yes/No or True/False). Default: False

See the [documentation on the debug setting](#) for details.

`label:`

Single value, type: string. Default: %

A descriptive name for this device which will show up in the service menu and reports.

`reset_events:`

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, reset this extra ball, meaning it can be awarded to a player again even if it has previously been awarded.

tags:

List of one (or more) values, each is a type: string. Default: None

Special / reserved tags for extra balls: *None*

See the [documentation on tags](#) for details.

fadecandy:

Config file section

Valid in machine config files	YES
Valid in mode config files	NO

The fadecandy: section of your config is where you...

Todo: Add description.

Optional settings

The following sections are optional in the fadecandy: section of your config. (If you don't include them, the default will be used).

dithering:

Single value, type: boolean (Yes/No or True/False). Default: True

Todo: Add description.

gamma:

Single value, type: number (will be converted to floating point). Default: 2.5

Todo: Add description.

keyframe_interpolation:

Single value, type: boolean (Yes/No or True/False). Default: True

Todo: Add description.

linear_cutoff:

Single value, type: number (will be converted to floating point). Default: 0.0

Todo: Add description.

linear_slope:

Single value, type: number (will be converted to floating point). Default: 1.0

Todo: Add description.

whitepoint:

List of one (or more) values, each is a type: number (will be converted to floating point). Default: 1.0, 1.0, 1.0

Todo: Add description.

fast:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The `fast:` section of your machine-wide config is where you configure hardware options that are specific to the FAST Pinball Controller. Note that we have a how to guide which includes [all the FAST-specific settings](#) throughout your entire config file, so be sure to read that if you have FAST hardware.

```
fast:
  ports: com3, com4, com5
  config_number_format: hex
  baud: 921600
  watchdog: 1s
  default_debounce_close: 10ms
  default_debounce_open: 30ms
```

Required settings

The following sections are required in the `fast:` section of your config:

default_normal_debounce_close:

Single value, type: time string (ms) (*Instructions for entering time strings*) .

Specifies the default value for the debounce time for switches that are configured with debounce: normal when they close.

Even though this is listed as a required setting, this entry is in the `mpfconfig.yaml` file, (with a value of 10ms), so you don't have to enter it here unless you want to override that.

Also, keep in mind that this setting is only a default. You can override it for any switch in that switch's config.

default_normal_debounce_open:

Single value, type: time string (ms) (*Instructions for entering time strings*) .

Specifies the default value for the debounce time for switches that are configured with debounce: normal when they open.

Even though this is listed as a required setting, this entry is in the `mpfconfig.yaml` file, (with a value of 10ms), so you don't have to enter it here unless you want to override that.

Also, keep in mind that this setting is only a default. You can override it for any switch in that switch's config.

default_quick_debounce_close:

Single value, type: time string (ms) (*Instructions for entering time strings*) .

Specifies the default value for the debounce time for switches that are configured with debounce: quick when they close.

Even though this is listed as a required setting, this entry is in the `mpfconfig.yaml` file, (with a value of 2ms), so you don't have to enter it here unless you want to override that.

Also, keep in mind that this setting is only a default. You can override it for any switch in that switch's config.

default_quick_debounce_open:

Single value, type: time string (ms) (*Instructions for entering time strings*) .

Specifies the default value for the debounce time for switches that are configured with debounce: quick when they open.

Even though this is listed as a required setting, this entry is in the `mpfconfig.yaml` file, (with a value of 2ms), so you don't have to enter it here unless you want to override that.

Also, keep in mind that this setting is only a default. You can override it for any switch in that switch's config.

ports:

List of one (or more) values, each is a type: string.

A comma-separated list of the serial port names your FAST controller uses.

Optional settings

The following sections are optional in the `fast:` section of your config. (If you don't include them, the default will be used).

baud:

Single value, type: integer. Default: 921600

The baud rate for the FAST COM ports.

config_number_format:

Single value, type: string. Default: hex

This setting controls whether you to specify the addresses of your lights, LEDs, coils, and switches by their integer values or as hex values. Note if you configure your *driverboards:* as *wpc* (in the *hardware:* section), then you also have the option of using the original WPC numbers from your operators manual.

debug:

Single value, type: boolean (Yes/No or True/False). Default: False

See the [documentation on the debug setting](#) for details.

hardware_led_fade_time:

Single value, type: time string (ms) ([Instructions for entering time strings](#)) . Default: 0

Controls how quickly LEDs will fade to their new color when they receive a color instruction from MPF.

The default is 0, which means if you set an LED to be red, it will turn red instantly. But if you set `hardware_led_fade_time: 20`, that means that when an LED receives an instruction to turn RED, it will smoothly fade from whatever color it is now to red over a period of 20ms.

You can play with different settings to pick something you like. Some people prefer the instant 0ms snappiness that's possible with LEDs. Others like to set this value to something like 100ms which gives LEDs the more gentle fade style reminiscent of incandescent bulbs.

watchdog:

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: 1000

The FAST controllers include a “watchdog” timer. A watchdog is a timer that is continuously counting down towards zero, and if it ever hits zero, the controller shuts off all the power to the drivers. The idea is that every time MPF runs a game loop (so, 30 times a second or whatever), MPF tells the FAST controller to reset the watchdog timer. So this timer is constantly getting reset and never hits zero.

But if MPF crashes or loses communication with the FAST controller, then this watchdog timer won’t be reset. When it hits zero, the FAST controller will kill the power to the drivers. This should prevent an MPF crash from burning up driver or somehow damaging your hardware in another way.

You can set the watchdog timer to whatever you want. (This is essentially the max time a driver could be stuck “on” if MPF crashes.) The default is 1 second which is probably fine for almost everyone, and you don’t have to include this section in your config if you want to use the default.

net_buffer:

New in version 0.31.

single|int|10

TODO

rgb_buffer:

New in version 0.31.

single|int|3

TODO

dmd_buffer:

New in version 0.31.

single|int|3

TODO

fast_coil_overwrites:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The fast_coil_overwrites: section of your config is where you...

Todo: Add description.

Optional settings

The following sections are optional in the `fast_coil_overwrites:` section of your config. (If you don't include them, the default will be used).

hold_power32:

Single value, type: integer. Default: None

Todo: Add description.

hold_pwm_mask:

Single value, type: integer. Default: None

Todo: Add description.

pulse_power32:

Single value, type: integer. Default: None

Todo: Add description.

pulse_pwm_mask:

Single value, type: integer. Default: None

Todo: Add description.

recycle_ms:

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: None

Todo: Add description.

fast_coils:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The fast_coils: section of your config is where you...

Todo: Add description.

Optional settings

The following sections are optional in the fast_coils: section of your config. (If you don't include them, the default will be used).

connection:

Single value, type: one of the following options: network, local, auto. Default: auto

Todo: Add description.

hold_power32:

Single value, type: integer. Default: None

Todo: Add description.

hold_pwm_mask:

Single value, type: integer. Default: None

Todo: Add description.

pulse_power32:

Single value, type: integer. Default: None

Todo: Add description.

pulse_pwm_mask:

Single value, type: integer. Default: None

Todo: Add description.

recycle_ms:

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: None

Todo: Add description.

fast_switches:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The fast_switches: section of your config is where you...

Todo: Add description.

Optional settings

The following sections are optional in the fast_switches: section of your config. (If you don't include them, the default will be used).

debounce_close:

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: None

Todo: Add description.

debounce_open:

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: None

Todo: Add description.

file_shows:*Config file section*

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES

The file_shows: section of your config is where you...

Todo: Add description.

flasher_player:*Config file section*

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES
Valid in <i>shows</i>	YES

Note: This section can also be used in a show file in the flashers: section of a step.

The flasher_player: section of your config is where you...

Todo: Add description.

Optional settings

The following sections are optional in the flasher_player: section of your config. (If you don't include them, the default will be used).

ms:

Single value, type: integer. Default: None

Todo: Add description.

Note: The flasher_player: section of your config may contain additional settings not mentioned here. Read the introductory text for details of what those might be.

flashers:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The flashers: section of your config is where you configure your machine's flashers. Note that flashers in MPF are lights that are connected to driver outputs. Most new custom machines use LEDs (or groups of LEDs) connected to the LED boards, so those configured as LEDs, not flashers. But for WPC and Stern machines with driver-based flashers, you'd configure those here.

Here's an example from a Williams *Road Show* machine:

```
flashers:
  f_little_flipper:
    number: c37
    label: Flasher above middle left flipper
    tags: white
  f_left_ramp:
    number: c38
    label: Flasher above Bob's Bunker
    tags: yellow
  f_back_white:
    number: c39
    flash_ms: 40
    label: Two white rear wall flashers
    tags: white
  f_back_yellow:
    number: c40
    flash_ms: 40
    label: Two yellow rear wall flashers
    tags: yellow
  f_back_red:
    number: c41
    flash_ms: 40
    label: Two red rear wall flashers
    tags: red
  f_blasting_zone:
    number: c42
    label: Blasting Zone flasher
    tags: white
  f_right_ramp:
    number: c43
    label: Flasher in front of Red
    tags: white
  f_jets_at_max:
    number: c44
    label: Playfield insert in the pop bumpers
    tags: white
```

Required settings

The following sections are required in the flashers: section of your config:

<FlasherName>:

Each subsection of flashers: is the name of the flasher as you'd like to refer to it in your game code. This can really be anything you want, but it's obviously best to pick something that makes sense.

number:

Single value, type: string.

This is the number for the flasher which specifies which driver output the flasher is physically connected to. The exact format used here will depend on the hardware controller and machine type you're using.

Since flashers are connected to driver outputs (just like coils), the number scheme here is identical to coils. Refer to the `number:` section of your hardware platform's coils: documentation for details.

The *Road Show* example file above is for WPC driver boards, which is why the flasher numbers are in the *Cxx* format.)

Optional settings

The following sections are optional in the flashers: section of your config. (If you don't include them, the default will be used).

debug:

Single value, type: boolean (Yes/No or True/False). Default: False

Todo: Add description.

flash_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, cause this flasher to flash using its default *flash_ms*: time.

flash_ms:

Single value, type: time string (ms) ([Instructions for entering time strings](#)) . Default: None

The default time, in milliseconds, that this flasher will flash for when it's sent a "flash" command.

hold_power:

Single value, type: integer. Default: None

Todo: Add description.

hold_power32:

Single value, type: integer. Default: None

Todo: Add description.

hold_pwm_mask:

Single value, type: integer. Default: None

Todo: Add description.

label:

Single value, type: string. Default: %

Todo: Add description.

platform:

Single value, type: string. Default: None

Name of the platform this flasher is connected to. The default value of None means the default hardware platform will be used. You only need to change this if you have multiple different hardware platforms in use and this coil is not connected to the default platform.

See the [Mixing-and-Matching hardware platforms](#) guide for details.

pulse_ms:

Single value, type: integer. Default: None

Todo: Add description.

pulse_power:

Single value, type: integer. Default: None

Todo: Add description.

pulse_power32:

Single value, type: integer. Default: None

Todo: Add description.

pulse_pwm_mask:

Single value, type: integer. Default: None

Todo: Add description.

pwm_off_ms:

Single value, type: integer. Default: None

Todo: Add description.

pwm_on_ms:

Single value, type: integer. Default: None

Todo: Add description.

recycle:

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: None

Todo: Add description.

tags:

List of one (or more) values, each is a type: string. Default: None

Todo: Add description.

flippers:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The flippers: section of your config contains all the settings for the flippers in a pinball machine.

Here's an example from a *Judge Dredd* machine with four flippers. (Note *Judge Dredd* technically has four flipper buttons too, but it's the style where you push the button part way in to flip the lower flipper, and all the way in to flip the upper flipper too. But as far as the game code is concerned, it sees two separate switches in each flipper button—one that's activated via the half-press, and the second via the full press.)

Also note that flippers are kind of complex and there are a lot of options. Read the [Flippers](#) tech note for details. (You should definitely read that first before digging into the configuration options here.)

Note: The flippers: section of the config is only used for controlled flippers in newer machines. Early solid-state (pre-WPC) machines used enable relays to enable the flippers, and those are configured elsewhere. (See the How To guides for details.)

```
flippers:
  lower_left:
    main_coil: c_flipper_lower_left_main
    hold_coil: c_flipper_lower_left_hold
    activation_switch: s_flipper_left
    eos_switch: flipperLwL_EOS
    label: Left Main Flipper
  lower_right:
    main_coil: c_flipper_lower_right_main
    hold_coil: c_flipper_lower_right_hold
    activation_switch: s_flipper_right
    eos_switch: flipperLwR_EOS
    label: Right Main Flipper
  upper_left:
    main_coil: flipperUpLMain
    hold_coil: flipperUpLHold
    activation_switch: flipperUpL
    eos_switch: flipperUpL_EOS
    label: Upper Left Flipper
  upper_right:
    main_coil: flipperUpRMain
    hold_coil: flipperUpRHold
```



```
activation_switch: flipperUpR
eos_switch: flipperUpR_EOS
label: Upper Right Flipper
```

Required settings

The following sections are required in the `flippers:` section of your config:

<name>:

Create sub-entries for each flipper in your machine. In the config file above, the flipper sub-entries are named *lower_left*, *lower_right*, *upper_left*, and *upper_right*.

activation_switch:

Single value, type: string name of a switches: device.

The switch that controls this flipper. (i.e. the flipper button)

main_coil:

Single value, type: string name of a coils: device.

The name of the main flipper coil. For flippers that only have single- wound coils, this is where you specify that coil. In that case you would also configure the lower-power hold option for this coil in the *coils:* section of your config.

Optional settings

The following sections are optional in the `flippers:` section of your config. (If you don't include them, the default will be used).

debug:

Single value, type: boolean (Yes/No or True/False). Default: False

See the [documentation on the debug setting](#) for details.

disable_events:

Changed in version 0.32.

List of one or more events (with optional delay timings), in the *device control events* format.

Default: `ball_will_end`, `service_mode_entered` (Note that if you add an entry here, it will replace the default. So if you also want the default value(s) to apply, add them too.)

Disables this flipper (meaning pushing the flipper button doesn't active the flipper).

enable_events:

One or more sub-entries, each in the format of type: str:ms. Default: ball_started

List of one or more events (with optional delay timings), in the *device control events* format.

Default: ball_started (Note that if you add an entry here, it will replace the default. So if you also want the default value(s) to apply, add them too.)

Enables this flipper.

eos_switch:

Single value, type: string name of a switches: device. Default: None

Todo: Add description.

eos_switch_overwrite:

One or more sub-entries, each in the format of type: str:str. Default: None

If you're using an end of stroke switch with this flipper, enter the switch name here.

hold_coil:

Single value, type: string name of a coils: device. Default: None

The name of the hold coil winding for dual-wound flipper coils.

hold_coil_overwrite:

One or more sub-entries, each in the format of type: str:str. Default: None

Todo: Add description.

label:

Single value, type: string. Default: %

A descriptive name for this device which will show up in the service menu and reports.

main_coil_overwrite:

One or more sub-entries, each in the format of type: str:str. Default: None

Todo: Add description.

switch_overwrite:

One or more sub-entries, each in the format of type: str:str. Default: None

Todo: Add description.

tags:

List of one (or more) values, each is a type: string. Default: None

Special / reserved tags for flippers: *None*

See the [documentation on tags](#) for details.

use_eos:

Single value, type: boolean (Yes/No or True/False). Default: False

Controls whether an EOS switch is used to disable the main winding or to switch to lower-power pwm mode.

power_setting_name:

New in version 0.31.

TODO

include_in_ball_search:

Boolean (True/False or Yes/No). Default is False.

New in version 0.33.

Controls whether this flipper is included in ball search.

Usually flippers aren't included in ball search. However if you have upper flippers, it's probably good to include them in the ball search since it's often possible for an upper flipper to disable and hold a ball under the flipper. Usually this isn't an issue since the player can just flip to release the ball. However if the machine has tilted (or the flippers are otherwise disabled), then it's possible for a flipper to come down on the ball and get it stuck. So you definitely want to include upper flippers in ball search.

BTW, this is something that happened to us in *Wizard of Oz*, so that's how we thought to include an option for flippers in ball search. :)

ball_search_order:

Numeric value, default is 100

New in version 0.33.

A relative value which controls the order individual devices are pulsed when ball search is running. Lower numbers are checked first. See the [Ball Search](#) documentation for details.

ball_search_hold_time:

Single value, type: time string (*Instructions for entering time strings*) . Default: 1s

New in version 0.33.

How long this flipper will be activated for when it is activated during ball search.

playfield:

New in version 0.33.

The name of the playfield that this flipper is on. The default setting is “playfield”, so you only have to change this value if you have more than one playfield and you’re managing them separately.

game:

Config file section

Valid in machine config files	YES
Valid in mode config files	NO

The game: section of the machine config holds settings related to the game play.

```
game:
  balls_per_game: 3
  max_players: 4
```

Optional settings

The following sections are optional in the game: section of your config. (If you don’t include them, the default will be used).

add_player_switch_tag:

Single value, type: string. Default: start

The tag of the switch that’s used to request to add a player to an existing game. (We say “request to add a player” instead of “add a player” because it’s possible that adding a player is not allowed. For example, if the machine is set to require credits and there are not enough credits available, or the game already has the maximum number of players.)

This is the name of the tag in the tags: section of one of your switches.

allow_start_with_ball_in_drain:

Single value, type: boolean (Yes/No or True/False). Default: False

Controls whether it's possible to start a game when a ball is in a ball device that's tagged with drain but not home or trough. (This is needed in some older machines that have non-standard trough/drain device configurations.)

allow_start_with_loose_balls:

Single value, type: boolean (Yes/No or True/False). Default: False

Controls whether it's possible to start a game when balls are not all in ball devices tagged with home.

balls_per_game:

Single value, type: integer. Default: 3

How many balls the game is. Typically it's 3 or 5 but it can be anything. MPF doesn't care.

Note: This is a template setting

max_players:

Single value, type: integer. Default: 4

Controls the maximum number of players that can play a game.

Note: This is a template setting

start_game_switch_tag:

Single value, type: string. Default: start

The tag of the switch that's used to request to start a game. (We say "request to start a game" instead of "start a game" because it's possible that starting a game is not allowed. For example, if the machine is set to require credits and there are not enough credits available.)

This is the name of the tag in the tags: section of one of your switches.

gi_player:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES
Valid in <i>shows</i>	YES

Note: This section can also be used in a show file in the `gis:` section of a step.

The `gi_player:` section of your config is where you...

Todo: Add description.

Optional settings

The following sections are optional in the `gi_player:` section of your config. (If you don't include them, the default will be used).

brightness:

Single value, type: 2-byte hex value (00 to ff). Default: ff

Todo: Add description.

Note: The `gi_player:` section of your config may contain additional settings not mentioned here. Read the introductory text for details of what those might be.

gis:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The `gis:` section of the config file is for *GI (general illumination)* settings for hardware that uses them. (This is typically with only used when you're writing new code for an existing pinball machine.

Here's an example from *Judge Dredd*:

```
gis:
  gi01: # lower backglass
        number: G01
  gi02: # mid backglass and rear playfield
        number: G02
  gi03: # upper left backglass and slings, variable
        number: G03
```



```
gi04: # upper right backglass and Deadworld globe, variable
      number: G04
gi05: # coin slot lights & side cabinet fire buttons
      number: G05
```

Required settings

The following sections are required in the `gis:` section of your config:

number:

Single value, type: string.

This is the number of the GI string which specifies which output the GI is physically connected to. The exact format used here will depend on which control system you're using.

See the [hardware documentation for your platform](#) for details.

Optional settings

The following sections are optional in the `gis:` section of your config. (If you don't include them, the default will be used).

debug:

Single value, type: boolean (Yes/No or True/False). Default: False

Set this to *true* to add lots of logging information about this GI string to the debug log. This is helpful when you're trying to troubleshoot problems with this shot.

dimnable:

Single value, type: boolean (Yes/No or True/False). Default: False

Specifies whether this GI string is dimmable. See your hardware documentation for details.

disable_events:

One or more sub-entries, each in the format of type: str:ms. Default: None

Events that disable (turn off) this GI string. See the [Device Control Events](#) documentation for details.

enable_events:

One or more sub-entries, each in the format of type: str:ms. Default: machine_reset_phase_3

Events that enable (turn on) this GI string. See the [Device Control Events](#) documentation for details.

label:

Single value, type: string. Default: %

The plain-English name for this device that will show up in operator menus and trouble reports.

platform:

Single value, type: string. Default: None

Name of the platform this GI string is connected to. The default value of None means the default hardware platform will be used. You only need to change this if you have multiple different hardware platforms in use and this coil is not connected to the default platform.

See the [Mixing-and-Matching hardware platforms](#) guide for details.

tags:

List of one (or more) values, each is a type: string. Default: None

A list of one or more tags that apply to this device. Tags allow you to access groups of devices by tag name.

hardware:

Config file section

Valid in machine config files	YES
Valid in mode config files	NO

The hardware: section of your machine config file is where you configure the options for the [physical hardware controller boards](#) that MPF will use.

If you intend to use MPF with physical hardware, at a minimum you'll have a platform: and driverboards: section in your machine config, like this:

```
hardware:
  platform: fast
  driverboards: fast
```

Primary Platform Settings**platform:**

Single value, type: string. Default: smart_virtual

Specifies the default platform that will be used by all devices in the config. We say this is the “default” platform, because it’s possible to use more than one platform at time. (Maybe you use a P-ROC for coils and switches and a FadeCandy for RGB LEDs, etc.) See the [Mixing-and-Matching hardware platforms](#) for more details on this.

Valid platform options include: (Click on them for direct links to the configuration guide for that platform.)

- p_roc [Multimorphic P-ROC](#)
- p3_roc [Multimorphic P3-ROC](#)
- fast [FAST Pinball](#) (any controller)
- opp [Open Pinball Project](#) open source hardware
- spike [Stern SPIKE / SPIKE 2](#)
- smart_virtual [Virtual \(software only\)](#) that simulates switch changes based on coil actions.
- virtual [Virtual software-only](#), with no “smart” simulation.

driverboards:

Single value, type: string.

Specifies the default type of driver boards you’re using. If you have a home brew machine, this will probably match your platform. If you’re using an existing machine, then this will be whatever type of driverboard is installed in the machine.

- pdb P-ROC Driver Boards, PD-16, PD-8x8, etc.)
- fast FAST IO boards (0804, 1616, 3208, etc.)
- opp OPP wing boards
- wpc95 Williams WPC-95
- wpc Williams WPC
- wpcAlphaNumeric Williams WPC with alphanumeric 14-pin connected segmented display
- sternSAM Stern SAM
- sternWhitestar Stern Whitestar

Device-specific defaults

The following optional settings can be used to set default platforms for a specific class of devices. Note that virtual and smart_virtual are valid options for all of these, though they are not included in the lists below.

See the [MPF compatible control systems / hardware](#) section for details of how to use and setup each of these different types of platforms and hardware.

accelerometers:

Single value, type: string.

- p3_roc

coils:

Single value, type: string. Default: default

- p_roc
- p3_roc
- fast
- opp
- snux

dmd:

Single value, type: string. Default: default

p_roc fast

flashers:

Single value, type: string. Default: default

- p_roc
- p3_roc
- fast
- opp
- snux

gis:

Single value, type: string. Default: default

- fast
- opp
- p_roc

i2c:

Single value, type: string.

- i2c

leds:

Single value, type: string. Default: default

- p_roc
- p3_roc
- fast
- fadecandy
- opp
- openpixel

matrix_lights:

Single value, type: string. Default: default

- fast
- p_roc

rgb_dmd:

Single value, type: string. Default: default

- smartmatrix

servo_controllers:

Single value, type: string.

- i2c

switches:

Single value, type: string. Default: default

- p_roc
- p3_roc
- fast
- opp
- snux

high_score:

Config file section

Valid in <i>machine config files</i>	NO
Valid in <i>mode config files</i>	YES

Changed in version 0.31: (No longer valid in machine configs, just mode configs)

The high_score: section of your config is where you...

Todo: Add description.

Required settings

The following sections are required in the high_score: section of your config:

categories:

One or more sub-entries, each in the format of type: str:list.

Todo: Add description.

Optional settings

The following sections are optional in the high_score: section of your config. (If you don't include them, the default will be used).

award_slide_display_time:

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: 4s

Todo: Add description.

select_tag:

Deprecated since version 0.31.

shift_left_tag:

Deprecated since version 0.31.

shift_right_tag:

Deprecated since version 0.31.

defaults:

New in version 0.33.

image_pools:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES

The image_pools: section of your config is where you...

Todo: Add description.

images:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES

The images: section of your config is where you configure non-default parameter values for any image assets you want to use in your game. Note: You do *not* have to have an entry for every single image you want to use, rather, you only need to add individual assets to your config file that have settings which differ from other assets in that asset's folder. (This section is part of the MPF media controller and only available if you're using MPF-MC for your media controller.)

More information on working with assets is in the [Assets](#) section of the documentation.

Optional settings

The following sections are optional in the images: section of your config. (If you don't include them, the default will be used).

<name>:

Each sub-entry in your image: section is the name that MPF will use to refer to that asset. (In other words it's how you specify that asset in other areas of your config files.) The asset manager works by first scanning the file system to build up a list of asset files it finds. Then it looks at the config to see if there are any additional settings specified for each asset.

For example:

```
images:
  insert_coin:
    load: preload
  hello_face:
    file: hello_face_300.jpg
    load: None
```

So in the example above, if the asset manager found a file called `insert_coin.jpg` on disk, then it will also see the `insert_coin` entry in the config file and know that those two match. (The “match” is just based on the part of the file name without the extension, so the settings entry for `insert_coin:` would match `insert_coin.jpg` and `insert_coin.png`. In other words, don’t name two files with the same name if you want to keep them straight.)

file:

Single value, type: string. Default: None

Sometimes you might want to name a file one thing on disk but refer to it as another thing in your game and config files. In this case, you can create an `file:` setting in an asset entry. (Note the `file: hello_face_300.jpg` setting in the example above, and note that it includes the file extension.) In this example, you would refer to that image asset as `hello_face` even though the file is `hello_face_300`.

You might be wondering why this exists? Why not just change the file name to be whatever you want and/or who cares what the name is? The reason this function exists is because it allows for the separation of the actual file on disk from the way it’s called in the game. For example, you could use this to create two sets of assets—one for a traditional DMD and one for a color DMD—and then you could refer to the asset by its generic name throughout your configs. (In other words, you could swap out assets for different physical machine types without having to update your display code.) That said, we expect that 99% of people won’t use this `file:` setting, which is fine.

load:

Single value, type: string. Default: None

Specifies when this asset should be loaded. (See the [Assets](#) documentation for an explanation on loading.)

- *preload* (The asset is loaded when MPF boots and stays in memory as long as MPF is running.)
- *mode_start* (The asset is loaded when the mode starts and is unloaded when the mode ends. This option is only valid for asset files that are in mode folders, not machine-wide assets.)
- Anything else (or nothing at all) means that the asset is loaded “on demand” when it’s first called for. (At this point, assets loaded on demand stay in memory forever, but at some point we’ll change that so they get unloaded on demand too.)

Note that you can configure `load:` options in the [assets:](#) section of your config files. It’s nice to be able to override those on an asset-by-asset basis. For example, you might configure your assets for a mode to all load when the mode starts, but you could also create a few entries in your config files with `load: preload` for the assets that are needed for the intro show of the mode. That way that show can play while the other assets are loading in the background. (Of course you could also create a subfolder for

the assets that you want to preload and specific an assets: entry for that folder rather than specifying entries in your config for specific assets. The choice is up to you.)

info_lights:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The info_lights: section of a machine config file allows you to configure the “Info Lights” plugin to automatically set “status” lights based on different things that are happening in the game. This is very common in EM and older solid state machines, since they use lights to tell the player whose turn it is, what ball they’re on, etc.

Here’s an example info_lights: section from a machine configuration file:

```
info_lights:
  match_00:
    light: match00
  match_10:
    light: match10
  match_20:
    light: match20
  match_30:
    light: match30
  match_40:
    light: match40
  match_50:
    light: match50
  match_60:
    light: match60
  match_70:
    light: match70
  match_80:
    light: match80
  match_90:
    light: match90
  ball_1:
    light: bip1
  ball_2:
    light: bip2
  ball_3:
    light: bip3
  ball_4:
    light: bip4
  ball_5:
    light: bip5
  player_1:
    light: player1
  player_2:
    light: player2
  tilt:
    light: tilt
```



```
game_over:
  light: gameOver
```

The way info lights work is pretty simple. There are sub-sections that represent different lights that may be in your machine, and then under each of them you map them to the name of the light.

Then they pretty much just work automatically.

Note that the `light:` entry in each of these can be either a light or LED name, (but you use “light” regardless).

match_XX:

This section is for the match lights, with the “XX” replaced with the number of the match light. In the example configuration above, the machine has match lights that count up by tens (10, 20, 30...) which is why the `match_xx` entries here are `match_10`, `match_20`, `match_30`, etc. If your machine matches by the ones digit, then you’d enter these items as `match_1`, `match_2`, etc.

ball_XX:

This maps the ball-in-play number to the light.

player_XX:

This maps the current player to the number in the light. This plugin turns on each light when a new player joins a game. So it doesn’t show which player is up, rather, if you have a two-player game then both the `player_1` and `player_2` lights are lit. (So how does a player know that it’s his turn? That’s handled by the score reel lights.)

tilt:

Turns this light on when the machine tilts.

game_over:

Flashes this light when a game is not in progress at a rate of 1/2 sec on, 1/2 sec off.

keyboard:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The `keyboard:` section of your config is used to configure options for how you map computer keyboard keys to pinball machine switches and events. This is useful for testing your game from your computer when you’re not around your physical machine.

Note that you can also use the [MPF Monitor](#) for this, and since the Monitor was released, most people use that instead of the `keyboard:` section of a config. However the `keyboard:` section is still nice for down-and-dirty testing and for posting events.

Here's an example of it in action:

```
keyboard:
  z:
    switch: left_flipper
  slash:
    switch: right_flipper
  s:
    switch: start
  1:
    switch: trough1
    toggle: True
  2:
    switch: trough2
    toggle: True
  shift+p:
    switch: lock_post
    invert: True
  q:
    event: machine_reset
  ctrl+shift+4:
    event: advance_reel_test
    params:
      reel_name: score_1p_10
      direction: 1
```

You can also read more about the `keyboard:` section in the [Tutorial step 6: Add keyboard control](#) documentation.

Key & key combination entries

Once you create your `keyboard:` section, you create subsections for each key or key combination you want to configure. For simple keys (without modifiers), you can just enter the key. (In the sample file above, this is `z`, `s`, `1`, `2`, `q`, and `4`.)

These entries are not case sensitive.

Using special keys

For “special” keys, it’s probably just easiest to enter the keys as words. Here are some examples of words that map to keys:

- equals
- minus
- dash
- leftbracket
- rightbracket

- backslash
- apostrophe
- semicolon
- colon
- comma
- period
- slash
- question

Note that you can't use the Escape key because that's currently hard-coded to exit out of MPF when you hit it.

Note that this keyboard interface focuses on keys, not symbols. In other words the "plus" key is if you have a full size keyboard with a number pad which has a dedicated plus key. If you're using a laptop with the shared plus & equals key, that is the equals key, or the equals key with a shift modifier.

Adding SHIFT, CTRL, and ALT modifiers

Since there are probably more switches in your machine than there are keys on your keyboard, you can also specify key combinations along with the key entries. These are called "modifier keys," and MPF supports them in combination with regular keys, like this:

```
t:
    switch: foo
shift-t:
    switch: tilt
shift+ctrl+t:
    switch: slam_tilt
```

Starting in MPF 0.33, you can add `debug: true` in the `keyboard:` section to get a printout on the console of the current key and/or modifiers that are pushed down which is helpful in figuring out exactly what the modifier keys are called on your system.

Use it like this:

```
keyboard:
    debug: yes
```

This will print out results live as you hit keys and combinations which will look something like this:

```
KEYS: d
KEYS: s
KEYS: shift
KEYS: shift+s
KEYS: f
KEYS: super
KEYS: meta+c
KEYS: shift
KEYS: shift+d
KEYS: lctrl
```



```
KEYS: ctrl+f  
KEYS: escape
```

Options for each key & key combination

Once you enter the key and/or key combination, then you need to create a subsection which defines what this key or key combination does when it's hit. There are several options:

switch:

The switch name of the pinball machine switch you want this key (or key combination) to control.

toggle:

If True, then the key acts like a “push on / push off” key, where you just have to tap it once to hold the switch active. This is useful for switches in ball devices, since you don't want to have to hold down the keys on your keyboard forever whenever a ball is locked in a device. Default is *False*. You might want to create multiple entries for the same switch for different key combinations. For example:

```
1:  
    switch: trough1  
shift+1:  
    switch: trough1  
    toggle: True
```

In the above code, you can momentarily “tap” the *trough1* switch by hitting the *1* key, but if you want to lock that switch on, then you can push *Shift+1*.

invert:

If True, then this key is inverted, meaning the associated switch is active when you're not pushing the key down, and it's inactive when you're holding the key.

event:

You can specify an event name to be posted when this key is pressed. This is useful for testing when you want to test some part of your game code based on an event. For example, you could map a keyboard key to *clockwise_orbit_hit* event instead of having to hit the *left_orbit_enter* key quickly followed by the *right_orbit_enter* key. Events entered here are transmitted posted by the MPF core engine process.

mc_event:

This is similar to the *event:* entry, except an *mc_event* is posted as events in the media controller process, rather than in the MPF process.

params:

This section contains subsections which are a list of parameters that are posted along with the *event* or *mc_event* specified above. Using the following configuration file snippet as an example:

```
keyboard:
  4:
    event: advance_reel_test
    params:
      reel_name: score_1p_10
      direction: 1
```

This keyboard entry will post the event *advance_reel_test* when the 4 key is pressed, and it will pass the parameters *reel_name=score_1p_10* and *direction=1*.

kickbacks:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

New in version 0.32.

The *kickbacks:* section of your machine config is used to define *kickback mechanisms* which are a type of *autofire coil* that kicks the ball back into play, typically located in an outlane.

Example:

Listing 25.1: */config/config.yaml*

```
#config_version=4

coils:
  kickback_coil:
    number:
    pulse_ms: 100

switches:
  s_kickback:
    number:

kickbacks:
  kickback_test:
    coil: kickback_coil
    switch: s_kickback
    enable_events: kickback_enable
    disable_events: kickback_kickback_test_fired

ball_saves:
  kickback_save:
    balls_to_save: 1
    active_time: 5s
    enable_events: kickback_kickback_test_fired
```


Since kickbacks are a type of autofire coil, they have the same settings as [autofire_coils:](#). See that documentation for a list of all the settings and options.

kivy_config:

Config file section

Valid in machine config files	YES
Valid in mode config files	NO

The kivy_config: section of your config is where you...

Todo: Add description.

led_player:

Config file section

Valid in machine config files	YES
Valid in mode config files	YES
Valid in shows	YES

Note: This section can also be used in a show file in the leds: section of a step.

The led_player: section of your config is where you...

Todo: Add description.

Optional settings

The following sections are optional in the led_player: section of your config. (If you don't include them, the default will be used).

color:

Single value, type: string. Default: white

Todo: Add description.

fade:

Changed in version 0.32.

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: None

Todo: Add description.

Note: The led_player: section of your config may contain additional settings not mentioned here. Read the introductory text for details of what those might be.

led_settings:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The led_settings: section of your config is where you configure settings for RGB LEDs in your machine.

Optional settings

The following sections are optional in the led_settings: section of your config. (If you don't include them, the default will be used).

color_correction_profiles:

Single value, type: dict. Default: None

The color_correction_profile: section of your config is where you configure named color correction profiles which you can then apply to RGB LEDs. You could create a single profile here which you use for all of them, or create different ones for different groups of LEDs.

The following sections are optional in the color_correction_profile: section of your config. (If you don't include them, the default will be used).

gamma:

Single value, type: number (will be converted to floating point). Default: 2.5

Specifies the *gamma correction* value for the LEDs. The default is 2.5. This setting currently only affects LEDs connected to a FadeCandy LED controller.

linear_cutoff:

Single value, type: number (will be converted to floating point). Default: 0.0

This is best explained by quoting the FadeCandy documentation: By default, brightness curves are entirely nonlinear. By setting linearCutoff to a nonzero value, though, a linear area may be defined at the bottom of the brightness curve. The linear section, near zero, avoids creating very low output values that will cause distracting flicker when dithered. This isn't a problem when the LEDs are viewed indirectly such that the flicker is below the threshold of perception, but in cases where the flicker is a problem this linear section can eliminate it entirely at the cost of some dynamic range. To enable the linear section, set linearCutoff to some nonzero value. A good starting point is 1/256.0, corresponding to the lowest 8-bit PWM level.

This setting currently only affects LEDs connected to a FadeCandy LED controller.

linear_slope:

Single value, type: number (will be converted to floating point). Default: 1.0

Specifies the slope (output / input) of the linear section of the brightness curve for the LEDs. The default is 1.0. This setting currently only affects LEDs connected to a FadeCandy LED controller.

whitepoint:

List of one (or more) values, each is a type: number (will be converted to floating point). Default: 1.0, 1.0, 1.0

Specifies the white point (or white balance) of your LEDs. Enter it as a list of three floating point values that correspond to the red, blue, and green LED segments. These values are treated as multipliers to all incoming color commands. The default of 1.0, 1.0, 1.0 means that no white point adjustment is used. 1.0, 1.0, 0.8 would set the blue segment to be at 80% brightness while red and green are 100%, etc.

You can use this to affect the overall brightness of LEDs (e.g. 0.8, 0.8, 0.8 would be 80% brightness as every color would be multiplied by 0.8). You can also use this to affect the "tint" (lowering the blue, for example).

default_color_correction_profile:

Single value, type: string. Default: None

The name of the color correction profile that applies to an LED by default if that LED doesn't have a profile configured for it.

default_led_fade_ms:

Single value, type: integer. Default: 0

This is the default *fade_ms* that will be applied to individual RGB LEDs that don't have *fade_ms* settings configured. If you configure an individual LED's *fade_ms*, it will override this setting.

Todo: Verify platforms this works on.

led_stripes

Config File Section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

New in version 0.31.

A “led_stripe” will create “count” leds for you starting the number at “number_start”. If you need a prefix or suffix for the number you can use “number_template”. All settings in “led_template” will be applied to all LEDs. The only difference between *led_stripes* and *led_rings* is how the x/y coordinates are computed.

Here’s an example:

```
#config_version=4

led_stripes:
  stripe1:
    number_start: 10
    led_template:
      tags: test
    count: 5
    debug: True
  stripe2:
    number_start: 200
    number_template: 7-{}
    count: 5
    direction: 90
    start_x: 10
    start_y: 20
    distance: 5
    debug: True

led_rings:
  ring1:
    number_start: 20
    count: 12
    radius: 3
    start_angle: 90
    center_x: 100
    center_y: 50
    debug: True
```

number_start:

The integer value for the number for the first LED in the stripe. (MPF assumes that all the LEDs in the stripe are numbered sequentially.)

count:

The integer value for how many LEDs are in the stripe.

number_template:

MPF automatically configures the LEDs in a stripe. The first one uses the `number_start:` value, and then it counts up from there up through the `count:` value.

However, many hardware numbers for LEDs are not just vanilla numbers, rather they also include a board number or channel or something like that. The `number_template:` is where you specify what that number value looks like. Just use braces `{}` for the part you want replaced by a number.

The example config with a number template of `7-{}` with a number start of 200 and a count of 5 will create 5 LEDs with the numbers 7-200, 7-201, 7-202, 7-203, and 7-204.

start_x:

The “x” position of the first LED. (This is not used in MPF yet.)

start_y:

The “y” position of the first LED.

direction:

The angle (in degrees, 0-360) the this LED stripe is positioned on the playfield. This is used for the calculation of x/y positions of individual LEDs only.

distance:

The distance between individual LEDs (in relative size to the x/y coordinates of the `start_x:` and `start_y:` positions. This is used for the calculation of x/y positions of individual LEDs only.

led_template:

This is a list of sub-settings (indented) that are regular settings from the [leds:](#) section of your machine config. Any settings that are valid there are valid here, and they’re applied to all the LEDs in the stripe.

led_rings

Config File Section

Valid in machine config files	YES
Valid in mode config files	NO

New in version 0.31.

A “led_rings” will create “count” leds for you starting the number at “number_start”. If you need a prefix or suffix for the number you can use “number_template”. All settings in “led_template” will be applied to all LEDs. The only difference between *led_stripes* and *led_rings* is how the x/y coordinates are computed.

Here’s an example:

```
#config_version=4

led_stripes:
  stripe1:
    number_start: 10
    led_template:
      tags: test
    count: 5
    debug: True
  stripe2:
    number_start: 200
    number_template: 7-{}
    count: 5
    direction: 90
    start_x: 10
    start_y: 20
    distance: 5
    debug: True

led_rings:
  ring1:
    number_start: 20
    count: 12
    radius: 3
    start_angle: 90
    center_x: 100
    center_y: 50
    debug: True
```

number_start:

The integer value for the number for the first LED in the ring. (MPF assumes that all the LEDs in the ring are numbered sequentially.)

count:

The integer value for how many LEDs are in the ring.

number_template:

MPF automatically configures the LEDs in a ring. The first one uses the `number_start:` value, and then it counts up from there up through the `count:` value.

However, many hardware numbers for LEDs are not just vanilla numbers, rather they also include a board number or channel or something like that. The `number_template:` is where you specify what that number value looks like. Just use braces `{}` for the part you want replaced by a number.

The example config with a number template of 7-{} with a number start of 200 and a count of 5 will create 5 LEDs with the numbers 7-200, 7-201, 7-202, 7-203, and 7-204.

center_x:

The “x” position of the center of the ring. (This is not used in MPF yet.)

center_y:

The “y” position of the center of the ring.

start_angle:

The angle (in degrees, 0-360) of the first LED in the ring. This is used for the calculation of x/y positions of individual LEDs only.

radius:

The radius of the ring (in relative size to the x/y coordinates of the center_x: and center_y: positions. This is used for the calculation of x/y positions of individual LEDs only.

led_template:

This is a list of sub-settings (indented) that are regular settings from the [leds:](#) section of your machine config. Any settings that are valid there are valid here, and they’re applied to all the LEDs in the ring.

leds:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The leds: section of your config is where you. . .

Todo: Add description.

Required settings

The following sections are required in the leds: section of your config:

number:

Single value, type: string.

This is the number of the LED which specifies which output the LED is physically connected to. The exact format used here will depend on which control system you're using and how the LED is connected.

See the [How to configure "number:" settings](#) guide for details.

Optional settings

The following sections are optional in the `leds:` section of your config. (If you don't include them, the default will be used).

color_correction_profile:

Single value, type: string. Default: None

Todo: Add description.

debug:

Single value, type: boolean (Yes/No or True/False). Default: False

Todo: Add description.

default_color:

Single value, type: color (*color name*, *hex*, or list of values 0-255). Default: fffffff

Todo: Add description.

fade_ms:

Single value, type: time string (ms) ([Instructions for entering time strings](#)) . Default: None

Todo: Add description.

label:

Single value, type: string. Default: %

Todo: Add description.

off_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, turn this LED off (color “black”)

on_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, turn this LED on using it’s default_color:

platform:

Single value, type: string. Default: None

Name of the platform this LED is connected to. The default value of None means the default hardware platform will be used. You only need to change this if you have multiple different hardware platforms in use and this coil is not connected to the default platform.

See the [Mixing-and-Matching hardware platforms](#) guide for details.

polarity:

Single value, type: boolean (Yes/No or True/False). Default: False

Todo: Add description.

tags:

List of one (or more) values, each is a type: string. Default: None

Todo: Add description.

type:

Single value, type: string (case-insensitive). Default: `rgb`

This describes the channel order of this LED. Can be 1 to many channels (if supported by hardware). Valid channels: `r` (red), `g` (green), `b` (blue), `w` (white=minimum of red, green and blue), `+` (always on), `-` (always off).

When using serial LEDs (e.g. with FAST or Fadecandy), use `rgb` for WS2812 and `grb` for WS2811 LEDs.

x:

Single value, type: integer. Default: None

Todo: Add description.

y:

Single value, type: integer. Default: None

Todo: Add description.

z:

Single value, type: integer. Default: None

Todo: Add description.

light_player:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES
Valid in <i>shows</i>	YES

Note: This section can also be used in a show file in the `lights:` section of a step.

The `light_player:` section of your config is where you...

Todo: Add description.

Optional settings

The following sections are optional in the `light_player:` section of your config. (If you don't include them, the default will be used).

brightness:

Single value, type: 2-byte hex value (00 to ff). Default: ff

Todo: Add description.

fade:

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: 0

Todo: Add description.

logic_blocks:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES

The `logic_blocks:` section of your config is where you configure your logic blocks.

There are three sub-sections that go under the `logic_blocks:` section which each correspond to a different type of logic block:

- *accruals:*
- *counters:*
- *sequences:*

Click each of the links above for details and settings for each type of logic block.

logging:

```
logging:
  console:
    asset_manager: none
    ball_controller: none
```



```
ball_search: basic
bcp: basic
bcp_client: basic
bcp_interface: basic
bcp_server: basic
clock: none
config_players: none # todo
data_manager: none # todo subclasses
delay_manager: none
device_manager: none
event_manager: none
file_manager: none # todo
logic_blocks: none
machine_controller: basic
mode_controller: basic
placeholder_manager: none
platforms: none # todo
players: basic # todo
plugins: none # todo
score_reel_controller: none
scriptlets: none # todo
service_controller: basic
settings_controller: none
show_controller: none
switch_controller: basic
timers: none
```

file:

```
asset_manager: basic
ball_controller: basic
ball_search: basic
bcp: basic
bcp_client: basic
bcp_interface: basic
bcp_server: basic
clock: none
config_players: basic
data_manager: basic
delay_manager: none
device_manager: basic
event_manager: basic
file_manager: basic
logic_blocks: basic
machine_controller: basic
mode_controller: basic
placeholder_manager: basic
platforms: basic
players: full
plugins: basic
score_reel_controller: basic
scriptlets: basic
service_controller: basic
settings_controller: basic
show_controller: basic
switch_controller: full
```


timers: none

asset_manager:

ball_controller:

ball_search:

bcp:

bcp_client:

bcp_interface:

bcp_server:

clock:

config_players:

data_manager:

delay_manager:

device_manager:

event_manager:

file_manager:

logic_blocks:

machine_controller:

mode_controller:

placeholder_manager:

platforms:

players:

plugins:

score_reel_controller:

scriptlets:

service_controller:

settings_controller:

show_controller:

switch_controller:

timers:

machine:*Config file section*

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The machine: section of your config is where you...

Todo: Add description.

Optional settings

The following sections are optional in the machine: section of your config. (If you don't include them, the default will be used).

balls_installed:

Single value, type: integer. Default: 1

Todo: Add description.

min_balls:

Single value, type: integer. Default: 1

Todo: Add description.

machine_vars:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

New in version 0.32.

The machine_vars: section of your machine-wide config file lets you specify the initial state of machine variables that are set when MPF starts up.

Example:

```
#config_version=4

player_vars:
  some_var:
    initial_value: 4
  some_float:
    initial_value: 4
    value_type: float
  some_string:
    initial_value: 4
```



```
    value_type: str
    some_other_string:
        initial_value: hello
        value_type: str # required for non-ints

machine_vars:
    test1:
        initial_value: 4
        value_type: int
    test2:
        initial_value: '5'
        value_type: str

# below is the min config we need to be able to start a game

game:
    balls_per_game: 3

coils:
    eject_coil1:
        number:
    eject_coil2:
        number:

switches:
    s_start:
        number:
        tags: start
    s_ball_switch1:
        number:
    s_ball_switch2:
        number:
    s_ball_switch_launcher:
        number:

ball_devices:
    bd_trough:
        eject_coil: eject_coil1
        ball_switches: s_ball_switch1, s_ball_switch2
        debug: true
        confirm_eject_type: target
        eject_targets: bd_launcher
        tags: trough, drain, home
    bd_launcher:
        eject_coil: eject_coil2
        ball_switches: s_ball_switch_launcher
        debug: true
        confirm_eject_type: target
        eject_timeouts: 2s
        tags: ball_add_live
```


Settings

Each subsection in the `machine_vars:` section is the name of a machine variable to set. Then there are three sub-settings under there:

`initial_value:` (required)

The initial value of this machine variable that you're setting. This is set when MPF starts.

`value_type:`

Select one of the options from this list: `int` (integer), `float`, or `str` (string). The default is `"int"`, and there is no intelligence to try to detect which type of value you have, so if you have a floating point number or a string, you also need to set the `value_type`.

`persist:`

True/False value which controls whether this machine variable will be persisted to when MPF shuts down.

`magnets:`

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

New in version 0.32.

The `magnets:` section of your machine config is used to define magnet mechanisms from coils and (optionally) switches. There are settings that control the timing of grabbing, releasing, and "flinging" the ball.

Example:

Listing 25.2: `/config/config.yaml`

```
#config_version=4

coils:
  magnet_coil1:
    number:
    pulse_ms: 100
    hold_power: 3
  magnet_coil2:
    number:
    pulse_ms: 100
    hold_power: 3

switches:
```



```

grab_switch1:
  number:
grab_switch2:
  number:

magnets:
  magnet1:
    magnet_coil: magnet_coil1
    grab_switch: grab_switch1
    enable_events: magnet1_enable
    disable_events: magnet1_disable
    release_ball_events: magnet1_release
    fling_ball_events: magnet1_fling

  magnet_ball_save:
    magnet_coil: magnet_coil2
    grab_switch: grab_switch2
    enable_events: magnet_ball_save_enable
    disable_events: magnet_magnet_ball_save_grabbed_ball
    fling_ball_events: magnet_magnet_ball_save_grabbed_ball

ball_saves:
  magnet_save:
    balls_to_save: 1
    active_time: 5s
    enable_events: magnet_magnet_ball_save_grabbing_ball

```

magnet_coil:

The string name of the coil associated with this magnet. Note that this must be a coil listed in the [coils:](#) section of your machine config file.

This setting is required.

Note that if any of the magnet activation times are longer than 255ms and the magnet pulse power is 100%, then you will need to add `allow_enable: true` to the coil's entry in the `coils:` section of the machine config.

grab_switch:

The name of a switch (from the [switches:](#) section of your machine config file) that, when activated, causes the magnet to activate to (try to) grab the ball.

Default: None

grab_time:

Single value, type: time string (ms) (*Instructions for entering time strings*)).

Default: 1.5s

How long the magnet will be energized when attempting to grab a ball.

release_time:

Single value, type: time string (ms) (*Instructions for entering time strings*).

Default: 500ms

How long the magnet disables to release a ball.

fling_drop_time:

Single value, type: time string (ms) (*Instructions for entering time strings*).

Default: 250ms

How long the magnet is deactivated for before the “fling_regrab_time” when it’s flinging a ball.

fling_regrab_time:

Single value, type: time string (ms) (*Instructions for entering time strings*).

Default: 50ms

How long the “second” (fling) pulse is for when a magnet is flinging a ball after its dropped it.

enable_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the *Device Control Events* documentation for details on how to enter settings here).

Default: None

These events enable the magnet to grab a ball based on the grab_switch: being activated.

disable_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the *Device Control Events* documentation for details on how to enter settings here).

Default: None

These events mean the magnet will no longer try to grab a ball if the grab_switch: is activated.

reset_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the *Device Control Events* documentation for details on how to enter settings here).

Default: machine_reset_phase_3, ball_starting

These events release a grabbed ball and disable the magnet.

grab_ball_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here).

Default: None

These events cause the magnet to immediately attempt to grab a ball. The magnet will be activated for the `grab_time:`.

release_ball_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here).

Default: None

These events cause the magnet to deactivate for the `release_time:` setting.

fling_ball_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here).

Default: None

matrix_light_settings:

Config file section

Valid in machine config files	YES
Valid in mode config files	NO

The `matrix_light_settings:` section of your config is where you...

Todo: Add description.

Optional settings

The following sections are optional in the `matrix_light_settings:` section of your config. (If you don't include them, the default will be used).

default_light_fade_ms:

Single value, type: integer. Default: 0

Todo: Add description.

matrix_lights:*Config file section*

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The `matrix_lights:` section of your config is where you...

Todo: Add description.

Required settings

The following sections are required in the `matrix_lights:` section of your config:

number:

Single value, type: string.

This is the number of the light which specifies which output the light is physically connected to. The exact format used here will depend on which control system you're using and how the light is connected.

See the *How to configure "number:" settings* guide for details.

Optional settings

The following sections are optional in the `matrix_lights:` section of your config. (If you don't include them, the default will be used).

debug:

Single value, type: boolean (Yes/No or True/False). Default: False

Todo: Add description.

fade_ms:

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: None

Todo: Add description.

label:

Single value, type: string. Default: %

Todo: Add description.

off_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, turn this light off.

on_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, turn this light on.

platform:

Single value, type: string. Default: None

Name of the platform this light is connected to. The default value of None means the default hardware platform will be used. You only need to change this if you have multiple different hardware platforms in use and this coil is not connected to the default platform.

See the [Mixing-and-Matching hardware platforms](#) guide for details.

tags:

List of one (or more) values, each is a type: string. Default: None

Todo: Add description.

x:

Single value, type: integer. Default: None

Todo: Add description.

y:

Single value, type: integer. Default: None

Todo: Add description.**z:**

Single value, type: integer. Default: None

Todo: Add description.**mode:***Config file section*

Valid in <i>machine config files</i>	NO
Valid in <i>mode config files</i>	YES

The mode: section of a mode config file is used to specify settings for a that mode.

Note that this mode: section is different than the modes: section. (The modes: section is a machine-wide setting where you list all the modes that are made available to MPF when it boots up. The mode: section we're talking about here goes in a mode-specific config and holds the settings for that specific mode.)

Let's take a look at an example mode: section from a multiball mode:

```
mode:
    start_events: ball_starting
    stop_events: timer_mode_timer_complete, shot_right_ramp
    code: skillshot.SkillShot
    priority: 300
```

Optional settings

The following sections are optional in the mode: section of your config. (If you don't include them, the default will be used).

code:

Single value, type: string. Default: None

If you want to write some custom Python code for this mode, you can specify the name of your file as well as the class (a child class of Mode). This entry is completely optional. If you don't need to write custom Python code for this mode (i.e. if you can do everything you need to do with config files which will probably be the case 90% of the time, then you can skip this setting.)

priority:

Single value, type: integer. Default: 100

This is the numeric value that this mode will run at. (Note that this cannot be changed once the mode is running.) This priority affects two things:

- The priority order of the modes which affects the order shots and other “blockable” events are processed.
- The default priority that other things from this mode run at (shows, slides, sounds, etc.).

Our best practices are that you should have a 100-point separation between modes. (i.e. run your base mode at 100, a game mode at 200, maybe your extra ball awarded mode at 10,000, etc.) The reason for this is that with big spacing between modes, you still have room to adjust the relative priorities of things that happen within a mode without the risk of those things affecting other modes.

Warning: Keep your mode priorities between 100 and 1000000. MPF needs some built-in modes to run above and below your modes, so it has some things that run under 100 and over 1 million.

restart_on_next_ball:

Single value, type: boolean (Yes/No or True/False). Default: False

If you set this to *true*, a mode that was running when the ball ended that was also configured to stop on ball end will automatically start for the next ball this player has. This is managed on a per-player basis via a player variable `_restart_modes_on_next_ball` which maintains a list of the modes to be restarted.

start_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, cause this mode to start.

If the mode is already running when one of the start events is posted, that’s ok. (i.e. It won’t start over or break.)

For modes that you want to start when the player’s ball starts (like for your base mode, ball save, or skillshot, you’d enter *ball_starting* here. For modes that should start when some progress has been made in the game, enter the name of the event that represents when you want to start the mode. This could be the event from a shot being made, the resultant event from a logic block being completed, etc.

start_priority:

Single value, type: integer. Default: 0

Allows you to fine-tune the order that modes are started in.

By default, modes register their start event handlers based on their mode priority, meaning if two modes are both configured to start on the `ball_starting` event, the higher-priority one will start first.

This `start_priority`: setting allows you to specify a relative value that will be added to the mode's priority: for the purpose of controlling the start order. (You can specify positive or negative values here.)

Note that the `start_priority`: setting only matters when you have multiple modes that are set to start on the same event.

stop_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, cause the mode to stop which will remove itself from the list of active modes. All of the things you configured in this mode's config file will be unloaded. (i.e. slides and shows won't play, scoring and shot events are removed, etc.)

In the skillshot mode from the example above, there are two `stop_events`:. The first entry is the event that's posted when a timer called "mode_timer" is complete. (In this case this is a timed mode, so when that timer expires, the mode ends.) The second event is when the skillshot is made (the right ramp) in this case. (This is because once the skillshot is made, you want to remove this mode.)

If a mode is stopped and another one of the `stop_events` is posted, that's ok. The mode will remain stopped.

stop_on_ball_end:

Single value, type: boolean (Yes/No or True/False). Default: True

The default behavior for modes in MPF is that they're automatically stopped when the ball ends. Some modes (like the built-in *game* and *credit* modes) need to stay running even when the ball ends, so to support that you can add `stop_on_ball_end: false`.

Another use of this option is to retain each player's progress towards the mode's completion after draining a ball; allowing the player to start where they left off in the mode on the next ball. To retain the mode, you can use `stop_on_ball_end: false` to keep the state of the mode for each player between balls.

However, it is very likely that a mode will be left unfinished (open) after the final ball, causing MPF to shutdown unexpectedly. You will get an error similar to this:

```
AssertionError('Mode terra_2 is not supposed to run outside of game.',)
```

To avoid this unexpected crash of MPF, add `game_ending` to the `stop_events`:

```
mode:
  start_events: mode_terra_2_start
  stop_events: mode_complete, game_ending
  stop_on_ball_end: false
```


stop_priority:

Single value, type: integer. Default: 0

Control the order that modes stop.

By default, modes register their stop handlers at the level the mode is operating plus one. (Why +1? Because if you have one mode set to stop at an event and another mode set to start on the same event, automatically adding +1 to the stop event handler guarantees that the old mode will stop before the new mode starts.)

If you add stop priority, it's relative and added on top of the priority of the mode plus the +1. So if you have one mode you want to stop before another mode, you can simply add `stop_priority: 1` to that mode, and if other modes don't have a `stop_priority` set then they'll stop after it. (A higher number means that mode stops first.)

If you have a mode you want to stop last, then don't enter a `stop_priority` for it but enter `stop_priority: 1` for all the other modes you want to stop first. You can add different `stop_priority` values for different modes, and they will all stop in order, highest numeric value to lowest. Note that the `stop_priority` setting only matters when you have multiple modes that are set to end on the same `stop_event`.

use_wait_queue:

Single value, type: boolean (Yes/No or True/False). Default: False

Specifies whether this mode should "pause" the flow of MPF while this mode is running. This only works if the mode is started via a "queue" event (something like `ball_ending`, `game_ending`, etc.). When set to true, game flow will be halted as long as this mode is running. Game flow proceeds when this mode ends.

This is useful for things like bonus modes where you want the mode to finish before the game flow moves on with the next player's turn, or modes like match or high score entry where you want those to finish before the attract mode starts again.

game_mode:

New in version 0.32.

TODO

mode_settings:

Config file section

Valid in <i>machine config files</i>	NO
Valid in <i>mode config files</i>	YES

The `mode_settings:` section of your config is a generic section that contains settings that you might want to use in a specific mode. It's nice because it's pretty much ignored by the general MPF config processing, meaning you can put whatever settings you want in here for a specific mode.

In fact, several of the built-in MPF modes make use of the `mode_settings:` section, including:

- *End of Ball Bonus mode*

modes:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The modes: section of your config is where you...

Todo: Add description.

motors:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The motors: section of your config is where you...

Todo: Add description.

Required settings

The following sections are required in the motors: section of your config:

motor_coil:

Single value, type: string name of a coils: device.

Todo: Add description.

position_switches:

One or more sub-entries, each in the format of type: str:machine(switches).

Todo: Add description.

reset_position:

Single value, type: string.

Todo: Add description.

Optional settings

The following sections are optional in the motors: section of your config. (If you don't include them, the default will be used).

debug:

Single value, type: boolean (Yes/No or True/False). Default: False

Todo: Add description.

go_to_position:

One or more sub-entries, each in the format of type: str:str. Default: None

Todo: Add description.

label:

Single value, type: string. Default: %

Todo: Add description.

reset_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: machine_reset_phase_3, ball_starting

Todo: Add description.

tags:

List of one (or more) values, each is a type: string. Default: None

Todo: Add description.

mpf:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The mpf: section of your config is where you...

Todo: Add description.

Optional settings

The following sections are optional in the mpf: section of your config. (If you don't include them, the default will be used).

allow_invalid_config_sections:

Single value, type: boolean (Yes/No or True/False). Default: false

MPF will not raise a fatal error when on invalid section when you set this to true. This might be useful when you are developing a new feature and do not want to constantly update config_spec (the file which describes allowed sections).

auto_create_switch_events:

Single value, type: boolean (Yes/No or True/False). Default: True

MPF will post switch_event_active and switch_event_inactive (see below) when this is enabled.

default_flash_ms:

Single value, type: integer. Default: 50

Default flash_ms for all flashers when not overwritten.

default_pulse_ms:

Single value, type: integer. Default: 10

Default pulse_ms for all coils when not overwritten. This will be used when you do not specify any pulse_ms in your coil.

default_platform_hz:

New in version 0.33.

Single value, type: number (will be converted to floating point). Default: 1000.0

For all platforms non-tickless platforms we poll this often.

save_machine_vars_to_disk:

Single value, type: boolean (Yes/No or True/False). Default: true

If set to true MPF will persist machine_vars to disk in a background writer.

switch_event_active:

Single value, type: string. Default: %_active

If auto_create_switch_events is set to true this event will be posted after a switch turned active.

switch_event_inactive:

Single value, type: string. Default: %_inactive

If auto_create_switch_events is set to true this event will be posted after a switch turned inactive.

switch_tag_event:

Single value, type: string. Default: sw_%

This event will be posted for all tags after a switch turned active.

default_show_sync_ms:

New in version 0.32.

Default sync_ms for all shows when not specified otherwise.

mpf-mc:*Config file section*

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The mpf-mc: section of your config is where you configure options for the MC itself.

Required Settings

All of these settings are required in the mpf-mc: section. However, MPF-MC includes a default config file called `mconfig.yaml` which includes all these settings with their defaults. So you only need to add/enter these if you want to change something from the default.

bcp_port:

Single integer value, default is 5050.

This is the TCP port that the MC listens on for incoming BCP connections. If you change this from the

bcp_interface:

String, default is localhost.

todo

fps:

todo

allow_invalid_config_sections:

todo

multiball_locks:*Config file section*

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES

New in version 0.33.

The multiball_locks: section of your config is used to configure ball locks which will lock balls for multiball. Note that if you only want to hold a ball temporarily (like to play a show for an award) and then release it, use the *ball_holds:* section instead.

Multiball lock devices are smart. They work with physical ball devices but track the number of balls locked virtually which is not necessarily the same as the number of balls that are physically contained in a ball device.

When a ball is locked, it will add a new ball into play from the ball device tagged with `ball_add_live` unless the device that just locked it is full, in which case it will eject a ball from the full device.

Whenever a new ball is locked, the event `multiball_lock_<name>_locked_ball` is posted with an argument “total_balls_locked”. When the lock is full, it will post `multiball_lock_<name>_full`, which you can use as a start event for a related [multiballs:](#) to start multiball. (And since the multiball lock tracks the “virtual” ball lock count on a per-player basis, this will still work even if another player previously emptied out the lock. (In that case, the multiball will add any additional balls it needs from the trough.)

Here’s an example:

```
multiball_locks:
  bunker:
    balls_to_lock: 3
    lock_devices: bd_bunker
```

Each sub-entry under the `multiball_locks:` section is the name of the multiball lock (“bunker”) in the example above. Then each named ball lock has the following settings:

balls_to_lock: (Required)

Single value, type: integer.

The number of balls this ball lock should hold. If one of the associated lock devices receives a ball and this logical ball lock is full, then the ball device will just release the ball again.

lock_devices: (Required)

List of one (or more) values, each is a type: string name of a `ball_devices:` device.

A list of one (or more) ball devices that will collect balls which will count towards this lock.

locked_ball_counting_strategy:

New in version 0.33.8.

One of the following options: `virtual_only`, `min_virtual_physical`, `physical_only`, `no_virtual`. Default is `virtual_only`.

See the [general multiball lock documentation](#) for an explanation of how each of these works.

debug:

Single value, type: boolean (Yes/No or True/False). Default: False

See the [documentation on the debug setting](#) for details.

source_playfield:

Single value, type: string name of a ball_devices: device. Default: playfield

The name of the playfield that feeds balls to this lock. If you only have one playfield (which is most games), you can leave this setting out. Default is the playfield called *playfield*.

disable_events:

List of one or more events (with optional delay timings), in the *device control events* format.

Default: None (Note that if you add an entry here, it will replace the default. So if you also want the default value(s) to apply, add them too.)

Event(s) which disable this ball lock, meaning that balls that enter one of the lock devices don't count towards the lock. If you want to set up a ball lock that requires the player to "re-light" the lock after locking a ball, you can set this ball lock's "ball_locked" event as a disable event for this lock and then set some other shot that re-enables the lock as an enable event.

enable_events:

List of one or more events (with optional delay timings), in the *device control events* format.

Default: None (Note that if you add an entry here, it will replace the default. So if you also want the default value(s) to apply, add them too.)

Event(s) which enable this ball lock. If this multiball lock is disabled, then a ball entering one of its ball devices does not count towards the lock. You can use this in situations where a player has to hit some other shot to first re-light the lock before a ball can be locked. (In that case you'd use the event posted by the light lock shot as one of the enable_events here.

reset_all_counts_events:

List of one or more events (with optional delay timings), in the *device control events* format.

Event(s) which reset the locked ball counts for all players.

reset_count_for_current_player_events:

List of one or more events (with optional delay timings), in the *device control events* format.

Event(s) which reset the locked ball count for the current player.

multiballs:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES

The multiballs: section of your config is where you configure multiballs.

Here's an example which contains several different multiball configs. (In the real world, you'd probably only have one multiball for each mode.)

```
multiballs:
  add_a_ball:
    ball_count: 1
    ball_count_type: add
    shoot_again: 30s
    enable_events: mb4_enable
    disable_events: mb4_disable
    start_events: mb4_start
    stop_events: mb4_stop

  quick_2_ball:
    ball_count: 2
    ball_count_type: total
    shoot_again: 20s
    start_events: mb11_start
    ball_locks: bd_lock

  release_all_locked_balls:
    ball_count: current_player.lock_mb6_locked_balls
    ball_count_type: add
    shoot_again: 20s
    start_events: mb12_start
    ball_locks: bd_lock

  quick_add_2_ball:
    ball_count: 2
    ball_count_type: add
    shoot_again: 0
    start_events: mb6_start
    ball_locks: bd_lock
```

You can use the following settings for each multiball:

ball_count: (Required)

Single value, type: integer.

The number of balls this multiball should eject (and maintain during shoot again period). Note: It may eject more balls when using locks but only `ball_count` balls will be maintained during shoot again.

Note that you can use a *dynamic value* for this setting.

ball_locks:

List of one (or more) values, each is a type: string name of a ball_devices: device. Default: None

Use those devices first when ejecting balls to the playfield on multiball start. On start all balls from all locks will be ejected (maybe more than `ball_count`). If there are not enough balls in the lock more balls will be requested to the source_playfield.

debug:

Single value, type: boolean (Yes/No or True/False). Default: False

See the [documentation on the debug setting](#) for details.

disable_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, disable this multiball. When disabled, the other events (like start and add a ball) do not work. If this multiball is in a mode config, then it will also be disabled when the mode it's in stops.

enable_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, enable this multiball. Note that enabling a multiball is not the same as starting it, but the other events (like to start the multiball or, or add a ball, etc.) do not work unless this multiball is enabled.

Note that if you do not add any enable_events: (which is the default), this multiball will be automatically enabled when the mode it's in starts.

reset_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: machine_reset_phase_3, ball_starting

Event(s) that reset this multiball, which means they disable it as well as disabling shoot again and resetting the ball add counts to 0.

shoot_again:

Single value, type: time string (ms) ([Instructions for entering time strings](#)) . Default: 10s

Specifies a time period for "shoot again" which is a sort of automatic ball save for multiballs. The timer will start when this multiball starts, and any balls that drain during this time will be re-added into play.

source_playfield:

Single value, type: string name of a ball_devices: device. Default: playfield

The name of the playfield (from the playfields: section of your machine config that this multiball will add balls to. You don't have to worry about this unless you have multiple playfields that you're managing separately (which is rare, usually only in head-to-head type games).

start_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, start the multiball. Note that these events will only have an effect if this multiball is enabled.

stop_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, stop the multiball. If there are multiball balls on the playfield, there's nothing that can be done about that (unless you want to disable the flippers). However stopping the multiball will cut off the "shoot again" period.

add_a_ball_events:

New in version 0.33.

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, will add one ball into play. Posting an event multiple times will add one ball for each time the event is posted.

This is useful for "add-a-ball" functionality (which you can combine with a counter and/or conditional events if you want to cap how many total balls can be added into play).

start_or_add_a_ball_events:

New in version 0.33.

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, will either start the multiball, or, if it's started, will add another ball.

ball_count_type:

New in version 0.31.

Set this to either total or add. Default is total.

This setting controls the behavior of how the multiball calculates the number of balls it should add into play. Adjusting this setting is useful when you have multiple (or stacked) multiballs and you want to control how the combined counts work.

total Means the ball_count: setting will provide a target for the total number of balls that should be in play when this multiball starts. So if this multiball has a ball_count: 3, and it starts when 2 balls are live on the playfield, then this multiball will only add 1 more ball to bring the total to 3.

add Means that the ball_count: setting will specify the number of balls that are added into play on top of whatever number of balls are already in play. So if this multiball is set to ball_count: 2 and there are already 2 balls in play, then this multiball will add 2 more balls for a total of 4 balls live.

open_pixel_control:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The open_pixel_control: section of your config is where you...

Todo: Add description.

Optional settings

The following sections are optional in the open_pixel_control: section of your config. (If you don't include them, the default will be used).

connection_attempts:

Single value, type: integer. Default: -1

Todo: Add description.

connection_required:

Single value, type: boolean (Yes/No or True/False). Default: False

Todo: Add description.

debug:

Single value, type: boolean (Yes/No or True/False). Default: False

Todo: Add description.

host:

Single value, type: string. Default: localhost

Todo: Add description.

number_format:

Single value, type: one of the following options: int, hex. Default: int

Todo: Add description.

port:

Single value, type: int. Default: 7890

Todo: Add description.

opp:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The opp: section of your config is where you. . .

Todo: Add description.

Required settings

The following sections are required in the opp: section of your config:

ports:

List of one (or more) values, each is a type: string.

Todo: Add description.

Optional settings

The following sections are optional in the opp: section of your config. (If you don't include them, the default will be used).

baud:

Single value, type: integer. Default: 115200

Todo: Add description.

debug:

Single value, type: boolean (Yes/No or True/False). Default: False

Todo: Add description.

chains:

New in version 0.31.

TODO

poll_hz:

New in version 0.33.

How many times per section the OPP hardware is polled for switch changes. Default is 100.

opp_coils:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The opp_coils: section of your config is where you...

Todo: Add description.

Optional settings

The following sections are optional in the `opp_coils:` section of your config. (If you don't include them, the default will be used).

`hold_power16:`

Single value, type: integer. Default: None

Todo: Add description.

`recycle_factor:`

Single value, type: integer. Default: None

Todo: Add description.

`osc:`

Config file section

Deprecated since version 0.33.

`p3_roc:`

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The `p3_roc:` section of your config is where you...

Todo: Add description.

Optional settings

The following sections are optional in the `p3_roc:` section of your config. (If you don't include them, the default will be used).

debug:

Single value, type: boolean (Yes/No or True/False). Default: False

Todo: Add description.

lamp_matrix_strobe_time:

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: 100ms

Todo: Add description.

use_watchdog:

Single value, type: boolean (Yes/No or True/False). Default: True

Todo: Add description.

watchdog_time:

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: 1s

Todo: Add description.

p_roc:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The p_roc: section of your config is where you...

Todo: Add description.

Optional settings

The following sections are optional in the p_roc: section of your config. (If you don't include them, the default will be used).

debug:

Single value, type: boolean (Yes/No or True/False). Default: False

Todo: Add description.

dmd_timing_cycles:

List of one (or more) values, each is a type: integer. Default: None

Todo: Add description.

dmd_update_interval:

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: 33ms

Todo: Add description.

lamp_matrix_strobe_time:

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: 100ms

Todo: Add description.

use_watchdog:

Single value, type: boolean (Yes/No or True/False). Default: True

Todo: Add description.

watchdog_time:

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: 1s

Todo: Add description.

p_roc_coil_overwrites:*Config file section*

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The p_roc_coil_overwrites: section of your config is where you...

Todo: Add description.

Optional settings

The following sections are optional in the p_roc_coil_overwrites: section of your config. (If you don't include them, the default will be used).

pwm_off_ms:

Single value, type: integer. Default: None

Todo: Add description.

pwm_on_ms:

Single value, type: integer. Default: None

Todo: Add description.

p_roc_coils:*Config file section*

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The p_roc_coils: section of your config is where you...

Todo: Add description.

Optional settings

The following sections are optional in the `p_roc_coils:` section of your config. (If you don't include them, the default will be used).

`pwm_off_ms:`

Single value, type: integer. Default: None

Todo: Add description.

`pwm_on_ms:`

Single value, type: integer. Default: None

Todo: Add description.

`physical_dmd:` (Deprecated)

Deprecated since version 0.31.

Replaced with [physical_dmds:](#).

`physical_dmds:`

Config file section

Valid in machine config files	YES
Valid in mode config files	NO

Changed in version 0.31.

The `physical_dmds:` section of your config is where you configure the settings for a physical DMD (dot matrix display). You only need this section if you have a physical monochrome DMD connected to a 14-pin header on a hardware controller. If you have an RGB DMD, configure that in the [physical_rgb_dmds:](#) section.

If you want to show a virtual DMD in an on-screen window, you configure that as a DMD widget, not here.

Note that there are no *height* and *width* settings here. The pixel size of your DMD is determined by the size of the source: display which drives the content for this DMD.

```
displays:
  dmd:
    width: 128
    height: 32
```



```
physical_rgb_dmds:  
  smartmatrix: # name of this DMD which can be whatever you want  
  brightness: .5  
  fps: 25  
  gamma: 2.5
```

Note that this section is called `physical_dmds`: (plural). Just like “switches” and “coils” and most everything else in MPF, this is a section that contains all your DMDs. Now since this is a DMD, you probably only have one, (though MPF can support as many as you want), but it’s important to note that you add a `physical_dmds`: section to your config, then under that you add an entry for a specific DMD (which can be whatever you want), and then you enter one or more of the following settings:

(If you don’t include any of the settings below, the default will be used).

brightness:

Single numeric value, Default: 1.0

A brightness multiplier for the DMD. Default is 1.0 which is full brightness, but if you want to dim the DMD, you can set this to some value lower than 1.0. (e.g. a value of 0.9 will be 90% brightness, etc.)

gamma:

Single numeric value, Default: 1.0

New in version 0.33.

Sets the gamma of the DMD. See [Gamma correction in MPF](#) for details.

Note that the default setting of 1.0 means that no gamma correction is used. Some physical DMDs do their own internal gamma correction, so this setting is fine. Others require pre-corrected gamma, so you can set that value here.

You might try a value of 2.2 first and adjust up or down until it looks right.

Important: Gamma setting is important!

We can’t stress enough that setting the gamma for your DMD is important for making it look right. So click the link above and make the adjustment. It’s a one-time thing.

fps:

Single value, type: integer. Default: 30

How many frames per second this DMD will be updated. A value of 30 should be fine and smooth. Some people claim that higher values look better, but as far as we can tell, that just makes your CPU work harder. But feel free to experiment.

luminosity:

List of one (or more) values, each is a type: number (will be converted to floating point). Default: .299, .587, .114

A list of three values (from 0.0 to 1.0) that represent the percentage of red, green, and blue that will be used to produce the monochrome colors from the source display. All three of these values should add up to 1.0.

only_send_changes:

Single value, type: boolean (Yes/No or True/False). Default: False

Specifies whether every frame is sent to the DMD, or only changed frames.

shades:

Single value, type: integer (must be a power of 2. Default: 16

How many shades the physical DMD can show. Modern pinball controllers support 16 shades.

source_display:

Single value, type: string. Default: dmd

The name of the display (from the `displays:` section of your machine config) that is the source for this physical DMD. Whatever's on the source display will be displayed on the DMD. If you don't specify a source, MPF will automatically use a source display called "dmd".

platform:

New in version 0.31.

Single value, type: string. Default: None

Name of the platform this DMD is connected to. The default value of None means the default hardware platform will be used. You only need to change this if you have multiple different hardware platforms in use and this coil is not connected to the default platform.

See the [Mixing-and-Matching hardware platforms](#) guide for details.

physical_rgb_dmd: (Deprecated)

Deprecated since version 0.31.

Replaced with `physical_rgb_dmds:`.

physical_rgb_dmds:*Config file section*

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

Changed in version 0.31.

The `physical_rgb_dmds:` section of your machine config is where you configure the settings for a physical RGB DMD (dot matrix display). You only need this section if you have a RGB DMD connected via USB. If you have an mono DMD, configure that in the *physical_dmds:* section.

If you want to show a virtual RGB DMD in an on-screen window, you configure that as a Color DMD widget, not here.

Note that there are no *height* and *width* settings here. The pixel size of your DMD is determined by the size of the source: display which drives the content for this DMD.

Here's an example:

displays:

dmd: width: 128 height: 32

physical_rgb_dmds:

smartmatrix: # name of this DMD which can be whatever you want brightness: .5 fps: 25
gamma: 2.5

Note that this section is called `physical_rgb_dmds:` (plural). Just like “switches” and “coils” and most everything else in MPF, this is a section that contains all your DMDs. Now since this is a DMD, you probably only have one, (though MPF can support as many as you want), but it's important to note that you add a `physical_rgb_dmds:` section to your config, then under that you add an entry for a specific DMD (which can be whatever you want), and then you enter one or more of the following settings:

(If you don't include any of the settings below, the default will be used).

brightness:

Single numeric value, Default: 0.5

A brightness multiplier for the DMD. Default is 0.5 which is 50% brightness, (because LED RGB DMDs are crazy bright!), but you can adjust this higher or lower as needed.

Note that brightness is closely related to gamma (see below). You'll probably want to adjust both of them together.

gamma:

Single numeric value, Default: 2.2

New in version 0.33.

Sets the gamma of the DMD. See *Gamma correction in MPF* for details.

Note that the default setting of 2.2 will probably be ok, though if your RGB DMD does its own internal gamma correction, you'll want to set the gamma to 1.0 (which is effectively disabling it).

Note that gamma is closely related to brightness (below). You'll probably want to adjust both of them together.

Important: Gamma setting is important!

We can't stress enough that setting the gamma for your DMD is important for making it look right. So click the link above and make the adjustment. It's a one-time thing.

fps:

Single value, type: integer. Default: 30

How many frames per second this DMD will be updated. Note that some RGB DMDs cannot handle the full 30fps, so you might have to dial this back to around 25 or so or else the DMD won't be able to keep up and will get behind.

only_send_changes:

Single value, type: boolean (Yes/No or True/False). Default: False

Specifies whether every frame is sent to the DMD, or only changed frames.

source_display:

Single value, type: string. Default: dmd

The name of the display (from the `displays:` section of your machine config) that is the source for this physical DMD. Whatever's on the source display will be displayed on the DMD. If you don't specify a source, MPF will automatically use a source display called "dmd".

platform:

New in version 0.31.

Single value, type: string. Default: None

Name of the platform this DMD is connected to. The default value of None means the default hardware platform will be used. You only need to change this if you have multiple different hardware platforms in use and this coil is not connected to the default platform.

See the [Mixing-and-Matching hardware platforms](#) guide for details.

player_vars:

Config file section

Valid in machine config files	YES
Valid in mode config files	NO

New in version 0.32.

The `player_vars:` section of your machine-wide config file lets you specify the initial state of player variables that are set for a player when the game starts.

Example:

```
#config_version=4

player_vars:
  some_var:
    initial_value: 4
  some_float:
    initial_value: 4
    value_type: float
  some_string:
    initial_value: 4
    value_type: str
  some_other_string:
    initial_value: hello
    value_type: str # required for non-ints

machine_vars:
  test1:
    initial_value: 4
    value_type: int
  test2:
    initial_value: '5'
    value_type: str

# below is the min config we need to be able to start a game

game:
  balls_per_game: 3

coils:
  eject_coil1:
    number:
  eject_coil2:
    number:

switches:
  s_start:
    number:
    tags: start
  s_ball_switch1:
    number:
  s_ball_switch2:
    number:
  s_ball_switch_launcher:
    number:

ball_devices:
  bd_trough:
    eject_coil: eject_coil1
    ball_switches: s_ball_switch1, s_ball_switch2
    debug: true
```



```

    confirm_eject_type: target
    eject_targets: bd_launcher
    tags: trough, drain, home
bd_launcher:
    eject_coil: eject_coil2
    ball_switches: s_ball_switch_launcher
    debug: true
    confirm_eject_type: target
    eject_timeouts: 2s
    tags: ball_add_live

```

Settings

Each subsection in the `player_vars:` section is the name of a player variable to set. Then there are two sub-settings under there:

`initial_value:` (required)

The initial value of this player variable that you're setting. This is set when the player is created.

`value_type:`

Select one of the options from this list: `int` (integer), `float`, or `str` (string). The default is “`int`”, and there is no intelligence to try to detect which type of value you have, so if you have a floating point number or a string, you also need to set the `value_type`.

`playfield_transfers:`

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The `playfield_transfers:` section of your config is where you...

Todo: Add description.

Required settings

The following sections are required in the `playfield_transfers:` section of your config:

`captures_from:`

Single value, type: string name of a `ball_devices:` device.

Todo: Add description.

eject_target:

Single value, type: string name of a ball_devices: device.

Todo: Add description.

Optional settings

The following sections are optional in the playfield_transfers: section of your config. (If you don't include them, the default will be used).

ball_switch:

Changed in version 0.32.

Single value, type: string name of a switches: device. Default: None

Todo: Add description.

debug:

Single value, type: boolean (Yes/No or True/False). Default: False

Todo: Add description.

label:

Single value, type: string. Default: %

Todo: Add description.

tags:

List of one (or more) values, each is a type: string. Default: None

Todo: Add description.

transfer_events:

New in version 0.32.

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted,

TODO

playfields:

Config file section

Valid in machine config files	YES
Valid in mode config files	NO

The playfields: section of your config is where you configure your playfields in your machine. You can have multiple playfields and MPF will track balls per playfield. One playfield should contain the tag *default* so that the game knows which playfield to use.

Optional settings

The following sections are optional in the playfields: section of your config. (If you don't include them, the default will be used).

ball_search_failed_action:

Single value, type: string. Default: new_ball

When ball search failed this action is taken. Either new_ball which will eject a new ball from the default default source device or end_game which will end the game.

ball_search_interval:

Single value, type: time string (ms) ([Instructions for entering time strings](#)) . Default: 150ms

The delay after each fired coil/searched device.

ball_search_phase_1_searches:

Single value, type: integer. Default: 3

Ball search will run in multiple phases with increasing intensity. For instance, in phase 1, only ball devices without a ball will be pulsed. This defines how many time phase 1 is repeated until ball_search proceeds to phase 2.

ball_search_phase_2_searches:

Single value, type: integer. Default: 3

Ball search will run in multiple phases with increasing intensity. For instance, in phase 2, all ball devices except the trough will try to dejam. This defines how many time phase 2 is repeated until ball_search proceeds to phase 3.

ball_search_phase_3_searches:

Single value, type: integer. Default: 4

Ball search will run in multiple phases with increasing intensity. For instance, in phase 3, all ball devices except the trough pulse their coil. This defines how many time phase 3 is repeated until ball search gives up.

ball_search_timeout:

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: 15s

ball_search_timeout configures the time of inactivity which has to pass until ball search starts.

ball_search_wait_after_iteration:

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: 5s

Extra delay after each iteration.

ball_search_block_events:

Default: flipper_cradle

New in version 0.33.

Event to block ball search. Used by flipper cradle.

ball_search_unblock_events:

Default: flipper_cradle_release

New in version 0.33.

Event to unblock ball search. Used by flipper cradle.

ball_search_enable_events:

Default: None

New in version 0.33.

Event to enable ball search.

ball_search_disable_events:

Default: None

New in version 0.33.

Event to disable ball search.

debug:

Single value, type: boolean (Yes/No or True/False). Default: False

Turn on/off debugging.

enable_ball_search:

Single value, type: boolean (Yes/No or True/False). Default: None

Changed in version 0.31.

Enable ball_search by default. Use with care during development since coils may hurt you. Should be enabled in any production machine.

label:

Single value, type: string. Default: %

Label for service menu.

tags:

List of one (or more) values, each is a type: string. Default: None

Set tag *default* to your default playfield. The game will use the default playfield to eject balls.

plugins:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The plugins: section of your config is where you...

Todo: Add description.

pololu_maestro:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The pololu_maestro: section of your config is where you configure the serial port that a Pololu Maestro servo controller is connected to.

When you attach a Pololu Maestro, two serial ports will appear. You want to specific the first (lower numbered) port here. For example:

```
pololu_maestro:  
  port: COM5
```

Note that there are a few other settings you need to configure in other areas to use a Pololu Maestro servo controller. See the How To guide for details.

Required settings

The following sections are required in the pololu_maestro: section of your config:

port:

Single value, type: string.

The name of the serial port.

Optional settings

The following sections are optional in the pololu_maestro: section of your config. (If you don't include them, the default will be used).

NOTE: The Pololu Maestro control center software and typical servo specifications work in units of microseconds. The values used here are in quarter-microseconds, so to make them correspond multiply your servo specs by 4. eg a servo with range of 600-2400 microsecods would be servo_min: 2400 and servo_max: 9600 for the full range.

servo_max:

Single value, type: integer. Default: 9000

Todo: Add description.

servo_min:

Single value, type: integer. Default: 3000

Todo: Add description.

queue_event_player:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES
Valid in <i>shows</i>	YES

New in version 0.32.

Note: This section can also be used in a show file in the queue_events: section of a step.

The queue_event_player: section of your config file is similar to the event_player:, except it posts *queue events* instead of regular events.

This section is particularly useful with the *queue_relay_player:*.

Here's an example:

```
queue_event_player:
  some_event:
    queue_event: my_queue
    events_when_finished: my_queue_done
```

In the example above, when the regular event *some_event* is posted, a new queue event called *my_queue* will be posted. After all the handlers for *my_queue* are done, the event *my_queue_done* will be posted. (This could be immediately if none of the handlers blocked it, or it could be awhile if one of those handlers is doing something else first.)

Settings**queue_event:**

The name of the queue event that will be posted when the parent event is posted. (required)

args:

A sub-configuration of key:value pairs that will be posted with the event. This setting is optional.

events_when_finished:

The event name that will be posted when all the handlers of this queue event are done processing it. This setting is optional.

queue_relay_player:

Config file section

Valid in machine config files	YES
Valid in mode config files	YES

New in version 0.32.

The `queue_relay_player` lets you “pause” queue event processing until some other event is posted, at which time the original queue event processing continues.

Here’s an example:

```
queue_relay_player:
  game_ending:
    post: start_my_mode
    wait_for: my_mode_done
```

This entry will watch for the `game_ending` event to be posted. (`game_ending` is a queue event.) When it’s posted, the queue relay player will pause the processing of the `game_ending` event and post a new event, the `start_my_mode` in this case.

You can use that new event to do whatever you want, like start some custom mode you want to run at game end before the machine goes back to the attract mode.

When your mode is done, you would configure it to post `my_mode_done` (or whatever the `wait_for:` is set to, and that will release the queue and progress will continue. If your mode doesn’t need to do anything, it can simply post the `wait_for:` event and exit.

Warning: If the `wait_for:` event is never posted, you will break your game since MPF will wait forever.

Note that each entry under `queue_event_player:` (the `game_ending:` in the example above) must be for a queue event. (You can see which events are queue events in the [event reference](#).) You can also use the [queue_event_player:](#) to “convert” a regular event into a queue event.

Settings

post:

The name of the event to post to trigger your action once the queue event has been posted. (required)

wait_for:

The name of the event this queue will wait for to continue. In other words, this is the event you need to post for the queue event to continue. (required)

args:

A sub-configuration of key:value pairs that will be posted with the event. This setting is optional.

random_event_player:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES
Valid in <i>shows</i>	YES

Note: This section can also be used in a show file in the randoms: section of a step.

The random_event_player: section of your config is where you...

Todo: Add description.

Required settings

The following sections are required in the random_event_player: section of your config:

event_list:

Deprecated since version 0.32.

(Renamed to “events:”)

events:

New in version 0.32.

List of one (or more) values, each is a type: string.

Todo: Add description.

force_different:

New in version 0.32.

single|bool|true

TODO

force_all:

New in version 0.32.

single|bool|true

TODO

disable_random:

New in version 0.32.

single|bool|false

TODO

scope:

New in version 0.32.

single|enum(player,machine)|player

TODO

score_reel_groups:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The score_reel_groups: section of your config is where you...

Todo: Add description.

Required settings

The following sections are required in the score_reel_groups: section of your config:

reels:

List of one (or more) values, each is a type: string name of a score_reels: device.

Todo: Add description.

Optional settings

The following sections are optional in the score_reel_groups: section of your config. (If you don't include them, the default will be used).

chimes:

List of one (or more) values, each is a type: string name of a coils: device. Default: None

Todo: Add description.

config:

Single value, type: string. Default: lazy

Todo: Add description.

confirm:

Single value, type: string. Default: lazy

Todo: Add description.

debug:

Single value, type: boolean (Yes/No or True/False). Default: False

Todo: Add description.

hw_confirm_time:

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: 300

Todo: Add description.

label:

Single value, type: string. Default: %

Todo: Add description.

lights_tag:

Single value, type: string. Default: None

Todo: Add description.

max_simultaneous_coils:

Single value, type: integer. Default: 2

Todo: Add description.

repeat_pulse_time:

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: 200

Todo: Add description.

tags:

List of one (or more) values, each is a type: string. Default: None

Todo: Add description.

score_reels:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The score_reels: section of your config is where you...

Todo: Add description.

Optional settings

The following sections are optional in the score_reels: section of your config. (If you don't include them, the default will be used).

coil_inc:

Single value, type: string name of a coils: device. Default: None

Todo: Add description.

confirm:

Single value, type: string. Default: strict

Todo: Add description.

debug:

Single value, type: boolean (Yes/No or True/False). Default: False

Todo: Add description.

hw_confirm_time:

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: 300

Todo: Add description.

label:

Single value, type: string. Default: %

Todo: Add description.

limit_hi:

Single value, type: integer. Default: 9

Todo: Add description.

limit_lo:

Single value, type: integer. Default: 0

Todo: Add description.

repeat_pulse_time:

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: 200

Todo: Add description.

rollover:

Single value, type: boolean (Yes/No or True/False). Default: True

Todo: Add description.

switch_0:

Single value, type: string name of a switches: device. Default: None

Todo: Add description.

switch_1:

Single value, type: string name of a switches: device. Default: None

Todo: Add description.

switch_10:

Single value, type: string name of a switches: device. Default: None

Todo: Add description.

switch_11:

Single value, type: string name of a switches: device. Default: None

Todo: Add description.

switch_12:

Single value, type: string name of a switches: device. Default: None

Todo: Add description.

switch_2:

Single value, type: string name of a switches: device. Default: None

Todo: Add description.

switch_3:

Single value, type: string name of a switches: device. Default: None

Todo: Add description.

switch_4:

Single value, type: string name of a switches: device. Default: None

Todo: Add description.

switch_5:

Single value, type: string name of a switches: device. Default: None

Todo: Add description.

switch_6:

Single value, type: string name of a switches: device. Default: None

Todo: Add description.

switch_7:

Single value, type: string name of a switches: device. Default: None

Todo: Add description.

switch_8:

Single value, type: string name of a switches: device. Default: None

Todo: Add description.

switch_9:

Single value, type: string name of a switches: device. Default: None

Todo: Add description.

tags:

List of one (or more) values, each is a type: string. Default: None

Todo: Add description.

scoring:

Config file section

Valid in <i>machine config files</i>	NO
Valid in <i>mode config files</i>	YES

Changed in version 0.31: (Now valid only in mode configs, not machine configs)

The scoring: section of your mode config lets you add, subtract, or replace player variables based on events that are posted.

At the most basic level, you can use this to add to a player's score (which is technically adding value to the player variable called *score*), but in reality you can affect any player variable.

Here's an example:

```
scoring:
  target_1_hit:
    score: 1000 # adds 1000 to the player's "score" variable
  ramp_1_hit:
    score: 10000 # adds 10,000 to the player's "score" variable
    ramps: 1 # adds 1 to the player's "ramps" variable
  ramp_1_timeout:
    ramps:
      score: 0 # sets the player's "ramps" variable to 0.
      action: set # means that this event will "set" (or reset) the variable to the value, rather
↳ than add to it
  ramp_2_hit:
    score:
      score: 25000 * current_player.ramps # multiplies the value of the current player's "ramps"
↳ variable by 25,000 and adds the result to the player's "score" variable
      block: true # "blocks" this scoring event from being passed to scoring sections from lower-
↳ priority modes
  counter_treasure_value_complete:
    treasure_name:
      string: RUBY # Sets the player's "treasure_name" variable to a string called "RUBY"
```

Settings

Like many sections of MPF configs, the scoring: section format is generically setup like this:

```
scoring:
  some_event:
    <settings>
```



```
some_other_event:
    <settings>
another_event:
    <settings>
```

The following settings can be used with each event section listed in your scoring section:

<any_player_variable>:

You can include any player variable under an event to add numeric value to that variable. (If the variable doesn't exist, it will set the player variable to that.) For example:

```
scoring:
    some_event:
        score: 1000
        aliens: 1
        bonus: 10
```

The above config will add 1000 to the “score” player variable, 1 to the “aliens” player variable, and 20 to the “bonus” player variable when the event called *some_event* is posted. Note that you don't even need to include a “score” if you just want to add to other player vars.

Note that you can use a [dynamic value](#) for this setting too, which means you can pull in values from other player variables, device states, etc. and do math on them.

action:

One of the following settings: add, set, add_machine, set_machine. Default is add.

New in version 0.32.

Changed in version 0.33.

By default, the scoring entries will be added to the existing value of a player variable. If you want to replace or reset the value of the player var, you can add `action: set` to the entry. However to do this, you have to indent that setting under the player var name, and then specify the value in the “score:” section. For example, if you want the example from the above section to reset the aliens player variable to 1 instead of adding 1 to the current value, it would look like this:

```
scoring:
    some_event:
        score: 1000
        aliens:          # the player var you want to reset
            score: 1      # the value you're resetting this player var to
            action: set    # means you're resetting it, rather than adding to it
        bonus: 10
```

Note: Resetting a player variable is confusing, because you need to include a `score:` entry to specify the value of the player variable you're resetting, and you do that via the `score:` section even though the player variable might be something other than “score”. We'll change this in a future version of MPF.

Starting in MPF 0.33, you can also add and set machine variables, by specifying `action: add_machine` or `action: set_machine`. In these cases the machine variable is specified just like the player variable in the “set” example above.

block:

New in version 0.32.

Adding `block: True` to a scoring entry means that MPF will “block” this scoring entry from being sent down to scoring entries in lower priority modes.

This is useful if you have a shot in a base mode that scores 500 points, but then in some timed mode you want that shot to be 5,000 points but you don’t also want the base mode to score the 500 points on top of the 5,000 from the higher mode.

Note that when you use `block`, you also have to include the `score:` setting indented, and that setting is called “score” even if you’re adding to a different player variable. For example:

```
scoring:
  ramp_1_hit:
    score:
      score: 5000
      block: true
```

There is also a shorthand way:

```
scoring:
  ramp_1_hit:
    score: 5000|block
```

string:

New in version 0.33.

Lets you set a player variable to a string value (text characters) rather than adding numeric value. This is useful for when you want to make slides that show some value and you need to “translate” some numeric value to words.

Here’s an example from *Brooks ‘n Dunn* where there is a player variable (set via a counter) which tracks the player’s current album value. We ue the scoring section tied to the events posted when the player variable changes and conditional events to set the current name of the album value, like this:

```
scoring:
  player_album_value{value==1}:
    album_name:
      string: SILVER
  player_album_value{value==2}:
    album_name:
      string: GOLD
  player_album_value{value==3}:
    album_name:
      string: PLATINUM
  player_album_value{value==4}:
    album_name:
```



```

    string: DOUBLE PLATINUM
  player_album_value{value==5}:
    album_name:
      string: QUINTUPLE PLATINUM
  player_album_value{value>5}:
    album_name:
      string: OFF THE CHARTS!

```

The above config lets us always have a player var called “album_name” we can use in slides and widgets which matches the value of the album, and it’s automatically updated whenever the player var “album_value” changes.

player:

New in version 0.33.

Lets you specify which player (by number) this scoring entry will affect. (Player 1 is would be player: 1 etc. This lets you effect the score or other player variables of players other than the current player.

If the player: setting is not used, then this scoring entry will default to the current player.

score:

todo

float:

todo

scriptlets:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The scriptlets: section of your config is where you...

Todo: Add description.

servo_controller:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The `servo_controller:` section of your config is where you...

Todo: Add description.

`servo_controllers:`

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The `servo_controllers:` section of your config is where you...

Todo: Add description.

Optional settings

The following sections are optional in the `servo_controllers:` section of your config. (If you don't include them, the default will be used).

`address:`

Single value, type: integer. Default: 64

Todo: Add description.

`debug:`

Single value, type: boolean (Yes/No or True/False). Default: False

Todo: Add description.

`label:`

Single value, type: string. Default: %

Todo: Add description.

platform:

Single value, type: string. Default: None

Name of the platform this servo controller is connected to. The default value of None means the default hardware platform will be used. You only need to change this if you have multiple different hardware platforms in use and this coil is not connected to the default platform.

See the [Mixing-and-Matching hardware platforms](#) guide for details.

servo_max:

Single value, type: integer. Default: 600

Todo: Add description.

servo_min:

Single value, type: integer. Default: 150

Todo: Add description.

tags:

List of one (or more) values, each is a type: string. Default: None

Todo: Add description.

servos:

Config file section

Valid in machine config files	YES
Valid in mode config files	NO

The `servos:` section of your config is where you specify any servo devices in your machine, as well as configuring their range of motion and a mapping of events that will cause the servos to move to certain positions.

Here's an example `servos:` section, with two servos defined called `servo1` and `servo2`:

```
servos:
  servo1:
    servo_min: 0.0
    servo_max: 1.0
```



```
positions:
    0.1: servo1_down
    0.9: servo1_up
reset_position: 0.5
reset_events: reset_servo1
number: 1
servo2:
    servo_min: 0.2
    servo_max: 0.8
    positions:
        0.2: servo2_left
        1.0: servo2_home
    reset_position: 1.0
    reset_events: reset_servo2
    number: 2
```

Then for each servo in your `servos:` section, the following settings apply:

Required settings

The following sections are required in the `servos:` section of your config:

number:

Single value, type: string.

This is the number of the servo which specifies which driver output the servo is physically connected to. The exact format used here will depend on which control system you're using and how the servo is connected.

See the [How to configure “number:” settings](#) guide for details.

Optional settings

The following sections are optional in the `servos:` section of your config. (If you don't include them, the default will be used).

debug:

Single value, type: boolean (Yes/No or True/False). Default: False

Enables more detailed debug information to be added to the log (when verbose logging is enabled).

label:

Single value, type: string. Default: %

A friendly name for this servo that will be used in reports and the service menu.

platform:

Single value, type: string. Default: None

Name of the platform this servo is connected to. The default value of None means the default hardware platform will be used. You only need to change this if you have multiple different hardware platforms in use and this coil is not connected to the default platform.

See the [Mixing-and-Matching hardware platforms](#) guide for details.

positions:

One or more sub-entries, each in the format of type: float:str. Default: None

This is a sub-section mapping of servo positions to MPF event names. For example:

```
positions:
    0.1: servo1_down
    0.9: servo1_up
    0.45: servo1_mid
```

In MPF, servo ranges of motion are represented as numbers between 0.0 and 1.0. So 0.0 puts the servo at the extreme end of its range on one side, and 1.0 moves it to the end of motion on the other side. You can use positions in between with as much precision as your servo controller will allow. (For example, a value of .4444 will tell the servo to move to 44.44% of the way between its minimum and maximum position.

The values in this positions: list represent MPF events that, when posted, tell this servo to move to a certain position. So in the example above, when the *servo1_up* event is posted, this servo will move to position 0.9 (90% of the way between its min and max).

You can add as many events here as you want, and the same event can be used for multiple servos.

reset_events:

Changed in version 0.32.

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted,

Default: machine_reset_phase_3, ball_starting, ball_will_end, service_mode_entered

A list of events, or a list of events with delays, that cause the servo to move to its reset position (discussed below).

Note that by default, *ball_starting* is a reset event, so if you don't want the servo to reset on the start of each ball, you can override that like this:

```
reset_events: machine_reset_phase_3, ball_will_end, service_mode_entered
```


reset_position:

Single value, type: number (will be converted to floating point). Default: 0.5

The position the servo will move to when its reset.

servo_max:

Single value, type: float. Default: 1.0

A numerical value that's sent to the servo which represents the servo's max position. The actual value for this will depend on your servo controller hardware. So controllers use values like 0.0 to 1.0 here, others use values like 3000 to 9000. So check your servo controller documentation.

Note that the position settings earlier are always 0.0 to 1.0, and the max (and min, discussed below) are used to calculate what actual values are sent to the servo.

servo_min:

Single value, type: float. Default: 0.0

Like servo_max: above, except the minimum lower-end setting for values that are sent to the servo controller.

tags:

List of one (or more) values, each is a type: string. Default: None

Tags work like tags for any device. Nothing special here.

include_in_ball_search:

Boolean (True/False or Yes/No). Default is True.

New in version 0.33.

Controls whether this servo is included in ball search.

ball_search_min:

Single value, type: number (will be converted to floating point). Default: 0.0

New in version 0.31.

The value of the initial position that this servo will go to in ball search.

First position in ball search

ball_search_max:

Single value, type: number (will be converted to floating point). Default: 1.0

New in version 0.31.

The value of the second position that this servo will go to in ball search.

ball_search_wait:

Time value. Default 5s.

New in version 0.31.

How long this servo will pause in each position (min and max) before moving to the other position while ball search is active.

settings:

Config File Section

New in version 0.31.

shot_groups:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES

You can group shots together via the shot_groups: section of your config file.

For example:

```
shot_groups:
  upper_lanes:
    shots: lane_l, lane_a, lane_n, lane_e
    rotate_left_events: sw_left_flipper
    rotate_right_events: sw_right_flipper
    reset_events: upper_lanes_default_lit_complete
    enable_events: ball_started
    disable_events: ball_ending
```

Creating a shot group has several advantages, including:

- You can add “rotation” events which shift the states of all the shots in the group to the left or right, like with flipper-controlled lane change or situations where the slingshots shift which lanes are lit.
- Any time the state of a member shot in a group changes, MPF will check to see what all the other shots’ states are. If they are all the same, it will post a “complete” event (in the form of `<shot_group_name>_<active_profile_name>_<profile_state_name>_complete`) which you can use to trigger scores based on complete, light shows, shot group resets, etc.

- Any time a member shot is hit, MPF will post an event (in the form of `<shot_group_name>_<profile_name_of_shot_that_was_hit>_<profile_state_name_of_shot_that_was_hit>_hit`). You can use this to tie scoring, sounds, or logic blocks to any shot being hit in a group, which can be easier than creating entries for each individual shot.
- Any time a member shot is hit, MPF will post an event (in the form of `<shot_group_name>_<profile_name_of_shot_that_was_hit>_hit`)
- Any time a member shot is hit, MPF will post an event (in the form of `<shot_group_name>_hit`)

At first all these events might seem confusing, but really they all exist to give you the most flexibility when looking to trigger different things based on shots that are part of a shot group being hit. For example, if a shot called *left_lane* is a member of a shot group called *lanes* with a profile called *skill* and a profile state *lit* is hit, the following six(!) events will be posted:

- `lanes_skill_lit_hit`
- `lanes_skill_hit`
- `lanes_hit`
- `left_lane_skill_lit_hit`
- `left_lane_skill_hit`
- `left_lane_hit`

This lets you dial-in on the amount of precision you need when you're tying game logic to shots and shot groups.

<name>:

Create one entry in your *shot_groups:* section for each group of shots in your machine. This name can be whatever you want, and it will be the name for this shot group which is used throughout your machine.

Optional settings

The following sections are optional in the *shot_groups:* section of your config. (If you don't include them, the default will be used).

advance_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here).

Default: None

Events in this list, when posted,

A list of one or more events that will advance all the shots in this shot group one step in the active profile. This can be a simple list of events or a time-delayed list. Advancing a shot does not post hit events and therefore does not trigger scoring or other events related to a shot hit. They are useful if you need to move a shot to a starting state.

debug:

Single value, type: boolean (Yes/No or True/False). Default: False

Set this to *true* to add lots of logging information about this shot to the debug log. This is helpful when you're trying to troubleshoot problems with this shot. Default is *False*.

disable_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted,

A list of one or more events that will disable this shot group. This can be a simple list of events or a time-delayed list. If you do not specify any *disable_events*, then MPF will automatically create *disable_events* based on the list in the *config_validator: shot_groups: disable_events:* section of your machine-wide config. (By default that's *ball_ended*.) If you specify any *disable_events* in your machine-wide config, then none of the default *disable_events* will be added. (i.e. if you also want to include the default *disable_events*, you will have to add them here too.) If you specify any *disable_events* in a mode-specific config, then those events are only active during that mode. Mode-specific *disable_events* are in addition to machine-wide *disable_events*.

disable_rotation_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted,

A list of one or more events that will disable rotation, meaning the states of the shots in this group will not be rotated if one of the *rotate_left_events*, *rotate_right_events*, or *rotate_events* is posted. This can be a simple list of events or a time-delayed list.

enable_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted,

A list of one or more events that will enable this shot group. (Enabling a shot group will also enable all of the individual shots that make up this group.) This can be a simple list of events or a time-delayed list. If a shot group is not enabled, then it will not post hit events and shot rotation is disabled. If you do not specify any *enable_events*, then MPF will automatically create enable events based on the list in the *config_validator: shot_groups: enable_events:* section of your machine-wide config. (By default that's *ball_started*, meaning your shot groups are automatically enabled when a ball starts.) If you specify any *enable_events* in your machine-wide config, then none of the default enable events will be added. (i.e. if you also want to include the default *enable_events*, you will have to add them here too.)

If you specify any *enable_events* in a mode-specific config, then those events are only active during that mode. Mode-specific *enable_events* are in addition to machine-wide *enable_events*.

enable_rotation_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted,

A list of one or more events that will allow the states of the shots in this group to be rotated (based on the *rotate_left_events*, *rotate_right_events*, or *rotate_events* as described above). This can be a simple list of events or a time-delayed list. If rotation is not enabled, rotation events being posted will have no effect. (Rotation is enabled by default.)

label:

Single value, type: string. Default: %

The plain-English name for this device that will show up in operator menus and trouble reports.

profile:

Single value, type: string. Default: None

The name of the *shot profile* that will be applied to all the shots in this shot group.

- If you're editing a machine-wide config file, then the profile name specified here will be the default profile for each shot in the group any time a mode-specific config doesn't override it. (If you don't specify a profile name, MPF will assign the shot profile called "default".)
- If you're in a mode configuration file, then this profile entry is the name of the shot profile that will be applied to each shot in this group only when this mode is active. (i.e. it's applied when the mode starts and it's removed when the mode ends.) Like other mode-specific settings, shot profiles take on the priorities of the modes they're in, so if you have a profile from a mode at priority 200 and another from priority 300, the profile from the priority 300 mode will be applied. If that mode stops, then the shot will get the profile from the priority 200 mode.

remove_active_profile_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted,

A list of one or more events that will cause the active shot profile to be removed from every shot in the group, and the next-highest priority profile to be applied. This can be a simple list of events or a time-delayed list.

reset_events:

One or more sub-entries, each in the format of type: str:ms. Default: None

A list of one or more events that will reset all the shots in this shot group. This can be a simple list of events or a time-delayed list. Resetting a shot group means that every shot in the group jumps back to the first state in whatever shot profile is active at that time.

rotate_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Same as rotate_right_events:.

rotate_left_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted,

This list of events that, when posted, will rotate the current state of each shot to the shot to its left. The state of left-most (i.e. first entry) in your shots: list will rotate over to the right-most shot. These states are based on whatever shot profile is active at that time.

rotate_right_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted,

This list of events that, when posted, will rotate the current lit and unlit shot states to the right. This can be a simple list of events or a time-delayed list. The state of right-most (i.e. last entry) in your shots: list will rotate over to the left-most shot.

shots:

List of one (or more) values, each is a type: string name of a shots: device. Default: None

The list of shots (from the shots: section of your config file) that make up this shot group. Order is important here if you want to implement shot rotation events. Individual shots can belong to more than group at the same time, which is useful in a lot of different situations. For example, you might have three banks of three standup targets each, and you can create shot groups for each bank with events that will be triggered when the individual bank is complete, and then you can create a fourth shot group with all nine targets in it which could post different events when all nine targets have been hit.

tags:

List of one (or more) values, each is a type: string. Default: None

A list of one or more tags that apply to this device. Tags allow you to access groups of devices by tag name.

shot_profiles:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES

The shot_profiles: section of your config is where you configure the settings for various *shot profiles* that you can then apply to your shots.

Here's an example:

```
shot_profiles:
  default:
    states:
      - name: unlit
        show: "off"
      - name: lit
        show: "on"
```

<name>:

This is the name of the shot profile, which is how you'll refer to it elsewhere in your config files when you apply it to shots. The sample shot_profiles: section of the config file above contains a profile named "default" (which is actually included in the system-wide mpfconfig.yaml file).

advance_on_hit:

Single value, type: boolean (Yes/No or True/False). Default: True

This setting controls whether the active shot profile advances to its next state when the shot is hit. The default is true, but you can set this to false if you want to manually advance the shot some other way. (If this is false, you can still advance the shot with *advance_events*, for example.)

block:

Single value, type: boolean (Yes/No or True/False). Default: true

Lets you control whether hits to this shot are propagated down to lower priority modes. The default value is true if you don't specify this, meaning that blocking is enabled

If you have block: true in a shot profile, then hits to that shot when that profile is applied only are registered in the highest mode where that shot is enabled. If you set block: false, then when a shot is hit in one mode it will also look down to lower priority modes where that shot is enabled. If that lower

priority mode has a different profile applied then it will also register a hit event based on that profile. This will continue until it reaches a level with `block: true` or until it reaches the end of the mode list.

This is better explained with an example.

Imagine you have four lanes at the top of your machine which you use in your base mode in a normal lane-change fashion. (Lanes are unlit by default, hit a lane and they light, complete all four lanes for an award.) Now imagine you also use those lanes for a skillshot where one of the lanes is flashing and you try to hit it while the skillshot is enabled. In this case, you'd have different shot profiles for each mode, perhaps the default profile in your base mode (with unlit->lit states) and a skillshot profile in your skill shot mode (with flashing->complete states).

By default, if the player hits the a lane when the skill shot mode is running, the skillshot profile is the active profile so it's the shot that gets the hit. But then when the skill shot mode ends, the lane the player just hit is not lit, since that shot profile was not active when it was hit. (In other words, the skillshot blocked the hit event.) So if you add `block: false` to your skillshot shot profile, then when the shot is hit when the skill shot mode is running, it will receive the hit and advance the shot from flashing to complete. Then the lower base mode will also get the shot, and it will advance its state from unlit to lit. The lights for the shot will only reflect the skillshot lights since it's the higher priority, however, you will get `yourshot_skillshot_flashing_hit` and `yourshot_default_unlit_hit` events since both the hits registered because you set the skillshot profile not to block the hit.

loop:

Single value, type: boolean (Yes/No or True/False). Default: False

Controls whether the states of this profile "loop" when they reach the end. If true, then the shot being hit when the profile is in the last state causes the profile to "loop" around back to the first state. This is useful if you want to create a "toggle" shot where you could create a profile with two steps (lit and unlit) and then set loop to be true. (If you have more than two steps in the shot profile, then the looping will go from the last one back to the first one.) The default is false, meaning when the profile reaches its last state, it will just stay there even if it's hit again.

player_variable:

Single value, type: string. Default: None

This is a profile setting that lets you specify the name of the player variable that will be used to track the status of this shot when this profile is applied. If you don't specify the name of a player variable, it will automatically use `<shot_name>_<profile_name>` as the player variable.

rotation_pattern:

List of one (or more) values, each is a type: string. Default: R

This setting lets you specify a custom rotation pattern that's used when an event from this profile's `rotation_events:` section is posted. You enter it as a list of Ls and Rs, for example:

```
rotation_pattern: L, L, L, L, R, R, R, R
```

In the above example, the first four times a `rotation_event` is posted, this shot group will rotate to the left, then the next four to the right, then the next four to the left, etc. The pattern will loop. This is

how you could specify a single lit target that “sweeps” back and forth across a group of five targets, for example. This only impacts *rotation_events*, not *rotate_left_events* and *rotate_right_events* since those events imply a direction.

show:

Single value, type: string. Default: None

The name of the show associated with this shot profile. Note that you can specify a single show which applies to the entire shot profile (here), or you can specify a different show for each step/state (in the *states:* section, covered below).

If you specify a show here, then the show will not auto play, and instead will advance to the next step with each step/state advancement of the shot. This is useful for simple things like turning a light on or off. For more complex scenarios, you can set a full show per step/state below.

show_when_disabled:

Single value, type: boolean (Yes/No or True/False). Default: False

Controls whether the lights or LEDs for shots which have this profile applied will be active when this shot is disabled. By default this is *true*, so if the shot profile associated with this shot has the light turning on, then when you disable the shot the light will stay on. Set it to *false* if you want the lights or LEDs to turn off when the shot is disabled. (Note that even when this is false, the lights or LEDs can still be controlled by other light scripts, light shows, manual commands, etc.)

state_names_to_not_rotate:

List of one (or more) values, each is a type: string. Default: None

This works like *state_names_to_rotate*, except it’s the opposite where you can enter the names of states to not rotate. You don’t need to use both—the options are here just for convenience.

state_names_to_rotate:

List of one (or more) values, each is a type: string. Default: None

This is a list of state names that will be used to determine which shots in a shot group will be rotated. By default, all states are included. But this can be nice if you only want to rotate a subset of the states. For example, if you have a shot group with a bunch of lights that represent modes, you might have a shot profile with states called *unlit*, *active* (flashing), and *complete* (lit). You’d use these shots (and their lights) to track the game modes you’ve completed, so at any time, you’d have a bunch of unlit shots representing modes you haven’t completed yet, solidly lit shots for modes you’ve completed, and a single flashing shot representing the mode that will be started next. Then in your game if you wanted to rotate among the incomplete targets, you would set your shot profile so it only rotated those state names, like this

states:

The *states:* section contains the following nested sub-settings

Under each shot profile name, a setting called *states*: lets you specify various properties for the target in different states. You can configure multiple states in the order that you want them to be stepped through. (You use a dash, then a space, then a setting to indicate that items should be a list. The following sections explain the settings for each state:

name:

Single value, type: string.

This is the name of the step. In other words, it's what "state" the shot is in when this profile step is active.

action:

Single value, type: one of the following options: play, stop, pause, resume, advance, step_back, update. Default: play

Changed in version 0.31: (Added "step_back" state)

Specifies which show action is taken for the show on this state in the shot profile.

key:

Deprecated since version 0.31.

loops:

Single value, type: integer. Default: -1

Loops setting from the show player, controls how many times the show loops (-1 is unlimited).

manual_advance:

Single value, type: boolean (Yes/No or True/False). Default: False

If True, the show does not automatically advance to the next step.

priority:

Single value, type: integer. Default: 0

The priority shift of the show that's played.

reset:

Deprecated since version 0.31.

show:

Single value, type: string. Default: None

The name of the show that will be played when a shot with this profile applied is in this step (or state).

show_tokens:

One or more sub-entries, each in the format of type: str:str. Default: None

Show tokens for the show.

speed:

Single value, type: number (will be converted to floating point). Default: 1

Playback speed of the show.

start_step:

Single value, type: integer. Default: 1

The step number the show will start on.

sync_ms:

Changed in version 0.32.

Single value, type: integer. Default: None

The sync_ms value of the show.

Note: The states: section of your config may contain additional settings not mentioned here. Read the introductory text for details of what those might be.

shots:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES

The *shots:* section of your config file is where you define the shots in your machine. A *shot* is a switch, a series of switches that have to be hit in order, or an event or series of events.

Shots are used for things like standup targets, rollover lanes, drop targets, ramps, loops, orbits, etc.

Each shot can have a *shot profile* applied to it which defines what happens when its hit. For example the shot profile might specify that the shot starts unlit, then when it's hit it becomes complete. Or a

shot profile might specify that it's flashing slowly, and each hit makes it flash faster and faster until it's been hit enough times, etc.

You can specify different shot profile on a per-mode basis, meaning a shot can have one behavior in the base mode and then take on another behavior when a higher-priority mode is started. The tracking of various states of the shot profiles is maintained on a per-mode basis.

You can group multiple shots together into *shot groups* for group-level functionality like posting events when all the shots in a group in the same state (lit, unlit, complete, etc.) and for rotating the states of shots to the left or right based on certain events happening (slingshot hits, flipper button pushes, etc.). A shot can be a member of multiple groups at the same time.

Typically you'd define your shots in your machine-wide config (since the actual physical shots in your machine are defined by hardware and never change), and then you apply different profiles to the shots in various modes.

Here's a sample *shots:* section from a config file:

```
shots:
  lane_l:
    switch: lane_l
    show_tokens:
      light: lane_l
  lane_a:
    switch: lane_a
    show_tokens:
      light: lane_a
  lane_n:
    switch: lane_n
    show_tokens:
      light: lane_n
  lane_e:
    switch: lane_e
    show_tokens:
      light: lane_e
  upper_standup
    switch: upper_standup
    show_tokens:
      leds: led_17, led_19
  right_ramp:
    switch_sequence: right_ramp_enter, right_ramp_made
    time: 2s
  left_orbit:
    switch_sequence: left_rollover, top_right_opto
    time: 3s
  weak_right_orbit:
    switch_sequence: top_right-opto, top_center_rollover
    time: 3s
  full_right_orbit:
    switch: top_right_opto, left_rollover
    time: 3s
```

Create one entry in your *shots:* section for each shot in your machine. Don't worry about grouping shots here. (That's done in the *shot_groups:* section.) The shot name can be whatever you want, and it will be the name for this shot which is used throughout your machine. Remember that everything with at least one switch and a "state" is a shot, so standups, rollovers, inlane/outlines, ramps, loops. . . You

will have lots of shots in your game.

Each shot in your `shots:` section can have the following config options set:

Optional settings

The following sections are optional in the `shots:` section of your config. (If you don't include them, the default will be used).

`advance_events:`

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here).

Default: None

Events in this list, when posted, cause this shot to be advanced to its next state in the active shot profile. If the shot is on the last state, then it will roll over if the shot profile is configured to loop, otherwise it will do nothing. *Advance_events* are similar to *hit_events*, except *advance_events* are more “stealthy” in that they only advance the state (and update the lights or LEDs). They do not post hit events and therefore do not trigger scoring or other events related to a shot hit. They are useful if you need to move a shot to a starting state (like selecting a shot to be active for skill shot).

`cancel_switch:`

List of one (or more) values, each is a type: string name of a switches: device. Default: None

A switch (or list of switches) that will cause any in-progress switch sequence tracking to be canceled. (Think of it like a cancel “abort” switch.) If you enter more than one switch here, any of them being hit will cause the sequence tracking to reset. If MPF is currently tracking multiple in-process sequences, a `cancel_switch` hit will cancel all of them.

`debug:`

Single value, type: boolean (Yes/No or True/False). Default: False

Set this to *true* to add lots of logging information about this shot to the debug log. This is helpful when you're trying to troubleshoot problems with this shot.

`delay_switch:`

Parent setting for one (or more) sub-settings. Each sub-setting is a type: string name of a switches):m: device. Default: None

This lets you specify a switch along with a time value that will prevent this shot from tracking from being hit. In other words, the shot only counts if the `delay_switch` was *not* hit within the time specified. If you use this with a single switch shot, then the time must pass before the shot will count. If you use this with a `switch_sequence`, then the time must pass before a new sequence will start to be tracked. Enter this switch with a time value (in seconds or ms), like this:


```
shots:
  mode_start:
    switch: mode_start
    delay_switch:
      rear_entry: 1.5s
  rear_entry_mode_start:
    switch_sequence: rear_entry, mode_start
    time: 1.5s
```

The example above illustrates a typical use for this where you have a single switch which you can hit from the front, and then also a rear entry where a rear switch is hit then the main switch. Setting up the switch sequence for the rear entry is easy, but without the `delay_switch` on the front entry, then a ball going in the rear entry would trigger a hit event for the front shot too.

disable_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.)

Default: None

Events in this list, when posted, disable this shot. If a shot is disabled, then hits to it have no effect. (e.g. The shot will remain in whatever state it's in.)

enable_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.)

Default: None

Events in this list, when posted, enable this shot. If a shot is not enabled, then hits to it have no effect. (e.g. The shot will remain in whatever state it's in.)

hit_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.)

Default: None

Events in this list, when posted, cause this shot to be "hit". This is effectively the same thing as if the ball activated the switch associated with this shot, (or that the entire switch sequence has been completed), except it comes in via an event instead of from a switch activity.

label:

Single value, type: string. Default: %

The plain-English name for this device that will show up in operator menus and trouble reports.

profile:

Changed in version 0.32.

Single value, type: string. Default: profile

The name of the *shot profile* that will be applied to this shot.

- If you're editing a machine-wide config file , then the profile name specified here will be the default profile for that shot any time a mode-specific config doesn't override it. (If you don't specify a profile name, MPF will assign the shot profile called "default".)
- If you're in a mode configuration file , then this profile entry is the name of the shot profile that will be applied only when this mode is active. (i.e. it's applied when the mode starts and it's removed when the mode ends.) Like other mode-specific settings, shot profiles take on the priorities of the modes they're in, so if you have a profile from a mode at priority 200 and another from priority 300, the profile from the priority 300 mode will be applied. If that mode stops, then the shot will get the profile from the priority 200 mode.

Shots can have (and track) multiple profiles at the same time (up to one profile per mode). Only the show from the highest-priority profile will play though.

remove_active_profile_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, cause the active shot profile to be removed, and the next-highest priority profile to be applied. Default is *None*.

reset_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the [Device Control Events](#) documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, reset this shot. Resetting a shot means that it jumps back to the first state in whatever *shot profile* is active at that time.

show_tokens:

One or more sub-entries, each in the format of type: str:str. Default: None

A subsection containing key-value pairs that are passed to the show that's run when this shot is in a certain state.

For example, consider the following shot config:

```
shots:
  shot1:
    switch: switch1
    profile: flash
```



```
show_tokens:
  leds: led1
```

The shot above has a show token called *leds* which is set to *led1*. This means that when a show associated with this shot is played, if that show contains placeholder tokens for (leds), they will be dynamically replaced with the value of *led1* when that show is played by this shot.

The purpose of show tokens is so you can create reusable shows that you could apply to any shot.

For example, imagine if you wanted to create a shot to flash an LED between red and off. It might look like this:

```
# show to flash an LED

- time: 0
  (leds): red
- time: 1
  (leds): off
```

Assuming the “flash” profile (as defined in the profile: *flash* in the above shot) was configured for the state that show was in, when the shot entered that state, it would replace the (leds): section of the show with *led1*.

More information about [show tokens](#)

switch:

List of one (or more) values, each is a type: string name of a switches: device. Default: None

The name of the switch (or a list of switches) for this shot. You can use multiple switches if the shot happens to have multiple switches, though this is rare. (Maybe there are two standups on the sides of a ramp that you always want to be the same so you just create them as one logical shot?)

Do *not* enter multiple switches here for different shots, like for a bank of rollover lanes. In that case you would set up each shot as its own shot here and then group them via *shot_groups*:

Also do *not* enter multiple switches if you want the shot to be complete when all the switches are hit. (That’s what the *switch_sequence*: setting is for.) Entering multiple switches here is just in case you have a shot where you want any of the switches being hit to count as that shot being hit.

switch_sequence:

List of one (or more) values, each is a type: string name of a switches: device. Default: None

A *switch_sequence* is where you configure your shot so that multiple switches have to be hit, in order, for the shot to be registered as being hit. You can optionally specify a time limit for these switches (i.e. the sequence must be completed within the time limit) with the *time*: setting.

When the first switch in a sequence is activated, the shot will start watching for the next one. When that one is activated, it looks for the next, and so on. Once the last switch is activated, the shot is considered “hit”.

Notice in the example above that there are two different shots with the same switches, but the order of the switches is inverted between the two. This is because the *left orbit* and *right orbit* shots in this

machine use the same two switches, but the order the switches are activated in dictates which shot was just made.

Shots in MPF are able to track multiple simultaneous sequences in situations which is nice when multiple balls are on the playfield. If the first switch in a sequence is hit twice before the sequence completes, MPF will start tracking two sequences. Then when the next switch is hit, it will only advance one sequence. If the next switch is hit again, it will advance the other sequence. But if the next switch is never hit a second time, then the second shot will not complete.

switches:

List of one (or more) values, each is a type: string name of a switches: device. Default: None

This setting is the same as the switch: setting above. You can technically enter a single switch or a list of switches in either the switch: setting or the switches: setting, but we include both since it was confusing to be able to enter multiple switches for a singular “switch” setting and vice versa.

tags:

List of one (or more) values, each is a type: string. Default: None

A list of one or more tags that apply to this device. Tags allow you to access groups of devices by tag name.

time:

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: 0

This is the time limit the switches in the switch_sequence: section have to be activated in, from start to finish, in order for the shot to be posted. You can enter values with “s” or “ms” after the number, like *200ms* or *3s*. If you just enter a number then the system assumes you mean seconds. If you do not enter a time, or you enter a value of 0, then there is no timeout (i.e. the player could literally take multiple minutes between switch activations and the shot would count.)

sequence:

New in version 0.31.

Like switch_sequence:, except this setting is a list of events, rather than switches.

show_player:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES

Note: This section can also be used in a show file in the shows: section of a step.

The `show_player:` section of your config is where you start, stop, pause, (etc.) shows. Here's an example:

```
show_player:
  some_event: your_show_name
  some_other_event: another_show
```

In the example above, when the event `some_event` is posted, the show called `your_show_name` will be played (started). When the event `some_other_event` is posted, the show called `another_show` will be played.

Notice that the config above has simple key/value pairs in the form of `event: show`. You can list as many of those as you want in the show player, and when each event is posted, it will start the show with the same name.

However there are times when you might want to specify additional options for a show. Perhaps you want to change the playback speed, or configure how it repeats. In that case, instead of putting the show name on the same line as the event, you can put the show name on a new line under the event, and then add additional settings under it, like this:

```
show_player:
  some_event:
    your_show_name:
      loops: 0
  some_other_event:
    another_show:
      speed: 2
      sync_ms: 500
```

In the example above, the show `your_show_name` will play when the event `some_event` is posted, but instead of playing with the default settings only, it will also play with the setting `loops: 0` (meaning it will not loop and just play once). Same for the other show above, which will play with a `speed: 2` and `sync_ms: 500`.

You can also mix-and-match formats, like this:

```
show_player:
  some_event: your_show_name
  some_other_event:
    another_show:
      speed: 2
      sync_ms: 500
```

Settings

The following settings can be added under a show name. If you don't include them, the default will be used.

action:

Single value of one of the following options: `play`, `stop`, `pause`, `resume`, `advance`, `step_back`, `update`.

Default: `play`

Changed in version 0.31: (Added "step_back" state)

play Starts playing the show. This is the default action which will happen if you don't include an action: setting.

stop Stops the show. Removes and “undoes” anything the show did, and posts the show stop events.

pause Pauses the show by holding it at the current step. Posts the show pause events.

resume Resumes a previously paused show.

advance Manually advances a show to the next step. Posts the show advance events.

step_back Manually moves the show back to the previous step. Posts the show step_back events.

update Not yet implemented. In the future it will be used to change a setting of a running show, like changing the playback speed.

block_queue:

Single value, type: boolean (Yes/No or True/False). Default: False

New in version 0.32.

You can use `block_queue: yes` if you want the show to block a queue event until the show is done. Note that you can only use this if the event that starts the show is a *queue event*.

For example, the mode stopping events are queue events. So take a look at the following config:

```
show_player:
  mode_my_mode_stopping:
    show_1:
      block_queue: yes
```

In the example above, when the mode called *my_mode* posts its stopping event, *show_1* will start playing. However because this show is set to block the queue event, the mode stopping event will not finish until the show finishes. In other words, the mode will not fully stop, and the *mode_my_mode_stopped* event will not be posted until the show ends.

If you didn't use the `block_queue` setting, then the show would start and then stop right away since the mode would end and be over (and shows started in modes are stopped when those modes end).

If you used this setting, make sure that you don't have loops: -1, or a duration: -1 as the final step of the show, since those will mean the show will never end, and then the queue event will never be unblocked, and your machine will hang.

key:

Single value, type: string. Default: None

Used to set a unique identifier you can set when playing a show which can then be used later to identify a show you want to perform an action on.

loops:

Single value, type: integer. Default: -1

Controls the looping / repeating of the show. The default if you don't include this setting is `loops: -1` means that the show will repeat indefinitely until it's stopped.

If you just want a show to play once and then stop, use `loops: 0`.

Since this setting is the number of times it loops, the value will be one less than the number of times the show will play. (e.g. `loops: 1` means the show will loop once which means it will play through twice.)

Note that if a show only has one step, *loops* will be set to 0, regardless of the actual loops setting.

manual_advance:

Single value, type: boolean (Yes/No or True/False). Default: False

If you set this to yes/true, then the show will not auto-advance based on time. Instead you will have to manually advance the show step-by-step with additional `show_player` entries with `action: advance` entries.

This can be useful if you want to have some kind of slow progress based on a series of events instead of a show that auto plays.

For example:

```
show_player:
  some_event:
    show_1:
      manual_advance: yes
  some_advance_event:
    show_1:
      action: advance
```

In the example above, the event *some_event* will start *show_1*, but that show will stay on its first step since it's set to manually advance. Then each time the event *some_advance_event* is posted, *show_1* will advance to its next step.

priority:

Single value, type: integer. Default: 0

Adjusts the priority of the show that's played.

By default, shows play at the priority of the mode where the `show_player` entry is. So this setting merely adjusts the show's priority up or down. For example, if you have a mode running at priority 300, and a show in a `show_player` with the setting `priority: 10`, then that show will run at priority 310. Priorities can also be negative.

The show's priority affects the priority of everything it does. Sounds, slides, LEDs, etc.

show_tokens:

One or more sub-entries, each in the format of type: str:str. Default: None

Allows you to specify show token values that will be used to replace the show tokens in the show when it's played.

Read what show tokens are [here](#).

For example:

```
show_player:
  some_event:
    show1:
      show_tokens:
        led: right_inlane
```

In the example above, the show called “show1” will be played, but the show token called “led” in the show will be replaced at runtime with the value “right_inlane”.

speed:

Single value, type: number (will be converted to floating point). Default: 1

Controls the playback speed of the show. The default value of 1 means the show plays back at 1x speed. (In other words, it plays at the actual speed each step is configured for. In this case you don’t actually need to include the setting.)

If you want to play the show at 2x the speed, use speed: 2. If you want to play it at half speed, use speed: .5. Etc.

start_step:

Single value, type: integer. Default: 1

Which step the show starts on when it’s played.

Note that you can use a [dynamic value](#) for this setting.

sync_ms:

Changed in version 0.32.

Single value, type: integer. Default: None

Sets the sync_ms value of this show which will delay the start to a certain millisecond multiple to ensure that multiple shows started at different times all play in sync with each other.

See the [Synchronizing multiple shows](#) documentation for details.

Events posted by shows

You can configure shows to post certain events when things happen. These are useful (for example), to eject a ball when a show ends.

events_when_advanced:

New in version 0.32.

[List](#) of one (or more) names of events. Default: None.

Event(s) that will be posted when this show has been manually advanced to the next step.

events_when_completed:

New in version 0.32.

List of one (or more) names of events. Default: None.

Event(s) that will be posted when this show has completed, meaning it ran through to the last step and ended naturally.

Note that if a show loops, these events are *not* posted when the loop happens. (You can use the *events_when_looped* for that.) However if a show is set to loop a specific number of times and then ends, these events will be posted at the end.

Note that if you want an event to post whenever the show stops, even if it didn't make it all the way to the end, you can use *events_when_stopped*.

events_when_looped:

New in version 0.32.

List of one (or more) names of events. Default: None.

Event(s) that will be posted when this show has looped (meaning it reached the end and is jumping back to the first step).

events_when_paused:

New in version 0.32.

List of one (or more) names of events. Default: None.

Event(s) that will be posted when this show has been paused.

events_when_played:

New in version 0.32.

List of one (or more) names of events. Default: None.

Event(s) that will be posted when this show is played (started).

events_when_resumed:

New in version 0.32.

List of one (or more) names of events. Default: None.

Event(s) that will be posted when this show is resumed from a pause.

events_when_stepped_back:

New in version 0.32.

List of one (or more) names of events. Default: None.

Event(s) that will be posted when this show has been manually stepped back to the previous step.

events_when_stopped:

New in version 0.32.

List of one (or more) names of events. Default: None.

Event(s) that will be posted when this show has been stopped. Note that these events are posted anytime the show has been stopped, regardless of whether it made it to the end and stopped on its own, or whether it was stopped randomly where it was.

events_when_updated:

New in version 0.32.

List of one (or more) names of events. Default: None.

Event(s) that will be posted when this show has been updated. Note that the show “update” function has not been implemented yet, so this setting is more of a placeholder at the moment.

show_pools:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES

The show_pools: section of your config is where you...

Todo: Add description.

shows:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES

The shows: section of your config is where you...

Todo: Add description.

slide_player:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES
Valid in <i>shows</i>	YES

The `slide_player:` section of your config is where you configure slides to be shown (or removed) based on events being posted.

Note that the slide player is a *config_player*, so everything mentioned below is valid in the `slide_player:` section of a config file *and* in the `slides:` section of a show step.

Full instructions on how to use the `slide_player` are included in the *How to Show a Slide on a Display* guide. The documentation here is for reference later.

Generically-speaking, there are two formats you can use for `slide_player` entries: “express” and “full” configs. Express configs will look like this:

```
slide_player:
  event1: slide1
  event2: slide2
  event3: slide3
```

Full configs will look like this:

```
slide_player:
  event1:
    slide1:
      <settings>
  event2:
    slide2:
      <settings>
  event3:
    slide3:
      <settings>
```

In both cases, these configurations are saying, “When *event1* is posted, show *slide1*. When *event2* is posted, show *slide2*. Etc.”

This “express” config is down-and-dirty, with no options, to just show slides. The full config lets you specify additional options (based on the settings detailed below).

For example, the following config will show *slide_1* when *some_event* is posted, but it will also override the default settings and show the slide on the display target called *display1* and at a priority that’s 200 higher than the base priority.

```
slide_player:
  some_event:
    slide_1:
      target: display1
      priority: 200
```


Showing dynamically-created slides

Both of the examples so far assumed that you were using the slide player to show a slide that had already been defined in the *slides:* section of your config. However you can also define slides right in-line in your slide player.

The following config will show a slide called *slide_1* when the *some_event* is posted, but it assumes that *slide_1* does not yet exist, and it contains a list of widgets (one text widget and one rectangle widget) which will be added to that slide.

Note that slide names are global in MPF, so if you already had a slide defined called *slide_1* and you redefine it in your slide player like the example below, this new slide will become *slide_1* and the old one will be gone.

```
slide_player:
  some_event:
    slide_1:
      widgets:
        - type: text
          text: I AM A TEXT WIDGET
        - type: rectangle
          width: 200
          height: 100
          color: red
```

You can also mix-and-match defining a slide in the slide player as well as adjusting properties of how the slide is shown. Just add multiple settings, like this:

```
slide_player:
  some_event:
    slide_1:
      target: display2
      widgets:
        - type: text
          text: I AM A TEXT WIDGET
        - type: rectangle
          width: 200
          height: 100
          color: red
      transition: wipe
```

Remember that these slide player settings can also be used in show steps (in a *slides:* section). Any of the examples above apply, you just don't include the event name, like this:

```
#show_version=4

- time: 0
  slides: slide1
- time: +3
  slides: slide2
- time: +3
  slides:
    slide3:          # newly-defined slide here
      widgets:
        - type: text
          text: I AM SLIDE 3 IN THIS SHOW
```



```

        color: lime
- time: +3
  slides:
    slide4:
      transition:
        type: move_out
        duration: 1s
        direction: up

```

Here's a list of all the valid settings for individual slides in the `slide_player:` section of your config file or the `slides:` section of a show. Note that all of these are optional. Any that you do not include will be automatically added with the default values applied.

Settings

The following sections are optional in the `slide_player:` section of your config. (If you don't include them, the default will be used).

action:

Single value, type: one of the following options: `play`, `remove`. Default: `play`

play Makes the slide active. Note that the actual slide shown on a display will be whichever active slide has the highest priority, so depending on what other slides are active, this action might not technically show the slide.

Also note that if a transition is specified (either in the slide definition or the `transition:` section here, then that transition will be used when showing this slide.

remove Removes the slide from the list of active slides. If this slide is the highest priority slide that's currently showing, then the next-highest priority slide will be shown in its place.

If a `transition_out:` setting is used, then that transition will be used here.

For example, to remove `slide1` when the event `remove_slide_1` is posted:

```

slide_player:
  remove_slide_1:      # event name
  slide1:              # slide name
    action: remove

```

You can also specify a transition for the removal, like this:

```

slide_player:
  remove_slide_1:      # event name
  slide1:              # slide name
    action: remove
    transition: fade

```

expire:

Single value, type: time string (secs) ([Instructions for entering time strings](#)) . Default: None

Specifies that this slide should automatically be removed after the time has passed. When it's removed, whichever slide is the next-highest priority will be shown.

The expiration timer starts immediately, so if the slide you're displaying here doesn't end up being shown because it's not the highest-priority slide, the timer is still running in the background, and the slide will still be removed when the timer expires.

If a `transition_out:` is specified, it will be applied when the slide expires.

force:

Single value, type: boolean (Yes/No or True/False). Default: False

Forces this slide to be shown, even if it's not the highest priority. Note that if you add or remove a slide and the priority list is recalculated, whichever slide is the highest priority will be shown. This `force:` option is sort of a one-time thing. Really you should use priorities to control which slides are shown.

persist:

Deprecated since version 0.33.

priority:

Single value, type: integer. Default: None

An adjustment to the priority of the slide that will be shown.

In MPF, all slides have a priority. Only one slide is shown on a display at a time, and the slide with the highest priority is automatically shown. If that slide is removed, the next-highest priority slide is shown.

If you have a `slide_player:` section in a mode-based config file, then slides shown will automatically have the priority of the mode. (`slide_player:` sections from your machine-wide config file use priority 0.) However you can adjust the priority of a slide (up or down) by adding a `priority:` setting with a positive or negative value.

If a slide is being shown as part of a show, the slide will have the priority set to whatever the priority of the show is (which itself is also the priority of the mode unless you adjust it)

show:

Single value, type: boolean (Yes/No or True/False). Default: True

Specifies whether this slide should be shown. (It will only be shown if it's the highest priority slide for that display.) If you set `show: false`, then the slide will be created and added to the display's collection of slides, but it won't be shown.

Note that if you add or remove a slide and the priority list is recalculated, whichever slide is the highest priority will be shown. This `show:` option is sort of a one-time thing. Really you should use priorities to control which slides are shown.

slide:

New in version 0.32.

TODO

target:

Single value, type: string. Default: None

Specifies the display target this slide will be shown on. If you do not specify a target, then the slide will be shown on the default display.

In MPF, display targets are the names of the displays themselves. However there is also a *slide_frame* widget (literally a widget which you add to a slide which holds other slides, kind of line picture-in-picture). When you add a *slide_frame* to a slide, you give it a name, and that name is added to the list of valid targets.

So really the target: here is either the name of a display, or the name of a *slide_frame* where you want this slide to be displayed.

transition:

A sub-configuration of key/value pairs that make up the incoming transition that will be used when this slide is shown. See the [Slide Transitions](#) documentation for details.

Note that you can also configure a transition when the slide is defined in the [slides:](#) section of your config if you want to use the same transition every time for a slide and don't want to always have to define it here.

If you specify a transition in both places, the transition in the *slide_player* or *show* will take precedence.

transition_out:

A sub-configuration of key/value pairs that make up the incoming transition that will be used when this slide is removed. See the [Slide Transitions](#) documentation for details.

Note that you can add a transition out to the slide player when a slide is shown, and it will be "attached" to the slide and used when that slide is removed (either with the slide player or when a new slide is created with a higher priority than it).

Or you can specify a transition out when you remove the slide (with `action: remove`).

There can only be one transition between slides, so if an outgoing slide has a transition out set, and an incoming slide has a transition set, then the incoming transition will take precedence.

slides:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES

The `slides:` section of your config is where you pre-define “named” slides that you can then use later in shows and the `slide_player` section of a config file. (See the [How to Show a Slide on a Display](#) guide for details on this.)

Slide names are universal throughout MPF, so if you create two slides with the same name—even in different modes—one of them will overwrite the other and things will be confusing, so don’t do that.

See the [How to create slides](#) documentation for full details on how to create slides. (You should definitely “learn” about slides there. The settings here are mostly used for reference later.)

There are several different ways you can enter slides. In all cases, you’ll have a `slides:` section of your config, and then under that, you’ll have sub-entries which are slide names. But what is entered under each slide name varies.

Option 1: Slide with a widget

If you want to define a slide that only has a single widget, you can just add the [widget’s properties](#) under the slide name. In the example below, we’re defining two slides, one called `my_slide_1` and the other called `my_slide_2`, and they each only have a single widget.

```
slides:
  my_slide_1:
    type: text
    text: THIS IS MY SLIDE
  my_slide_2:
    type: text
    text: THIS IS ANOTHER SLIDE
    color: lime
    font_size: 25
```

Option 2: List of widgets

Of course many slides you’ll define will have more than one widget. To add multiple widgets to a slide, just enter them like you entered a single widget, but use a dash (and a space) to dictate where a new widget starts, like this:

```
slides:
  my_slide_1:
    - type: text
      text: THIS IS MY SLIDE
    - type: image
      image: johnny_5
  my_slide_2:
    - type: text
      text: THIS IS ANOTHER SLIDE
    - type: text
      y: 20%
      text: IT HAS MORE THAN 1 WIDGET
    - type: ellipse
      color: red
      width: 200
      height: 100
```


Option 3: Widgets under “widgets:” section

In addition to widgets, slides have other options (as described below), and sometimes you might want to define a slide that has widgets and slide settings. To do that, you need to move your widgets definition into a sub-section called “widgets:”, and then you can add the other slide settings under the slide along with the widgets.

Here’s an example. Note that the slide with multiple widgets is using the dash in the widgets: section to separate the individual widgets.

```
slides:
  my_slide_1:
    background_color: red
    widgets:
      type: text
      text: THIS IS MY SLIDE
  my_slide_2:
    widgets:
      - type: text
        text: THIS IS ANOTHER SLIDE
      - type: text
        y: 20%
        text: IT HAS MORE THAN 1 WIDGET
      - type: ellipse
        color: red
        width: 200
        height: 100
    expire: 2s
    transition:
      type: move_in
      direction: right
```

You can mix-and-match the three options for entering widgets as needed within the same slides: section of your config.

Creating a blank slide

If you want to create a blank slide (perhaps an empty canvas that you’ll populate via the widget player later?), then you need to tell the slides: section that you have an empty list. In YAML, that’s done with a [and] next to each other (which is confusing because it looks like a rectangle, but it’s not, like this: []).

You can use this format to create a blank slide with no options:

```
slides:
  my_blank_slide: []
```

Or you can use it to create a blank slide with options, but no widgets, like this:

```
slides:
  my_blank_slide:
    background_color: red
    widgets: []
```


Settings

The following sections provide additional options for your slide which you can use if you move the widgets into their own widgets: section. If you just include the widgets as top-level entries (like Options 1 and 2 above), then the default values for each of these settings below will be used.

background_color:

Single value, type: color (*color name, hex, or list of values 0-255*). Default: 000000ff

The background color of the slide. Details on how to enter color values are [here](#).

debug:

Single value, type: boolean (Yes/No or True/False). Default: False

Set to true/yes if you want to add addition debug information about this slide to the log. (Note this requires a verbose log to see.)

expire:

Single value, type: time string (secs) (*Instructions for entering time strings*) . Default: None

Sets an expiration time which will automatically remove this slide. If it's showing when it's removed, the next-highest priority active slide will be shown in its place.

Note that you can also configure expiration when the slide is shown (in either a show or via the slide_player), so you don't need to define an expire setting as part of the slide definition unless you want that expire time to be used every time the slide is shown.

If you specify an expire time in both places, the expire time in the slide_player or show will take precedence.

opacity:

Single value, type: number (will be converted to floating point). Default: 1.0

Sets the overall opacity of the slide. A value of 1.0 is fully opaque. A value of .5 means the slide is 50% transparent, and a value of 0 means the slide will be invisible and you'll probably be confused about why it's not showing up.

transition:

A sub-configuration of key/value pairs that make up the incoming transition that will be used when this slide is shown. See the [Slide Transitions](#) documentation for details.

Note that you can also configure a transition when the slide is shown (in either a show or via the slide_player), so you don't need to define a transition as part of the slide definition unless you want that transition to be used every time the slide is shown.

If you specify a transition in both places, the transition in the slide_player or show will take precedence.

widgets:

A sub-configuration of widgets that will be added to this slide when it's created. See the examples above for details and syntax options.

smart_virtual:

New in version 0.31.

TODO

smartmatrix:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The smartmatrix: section of your config is where you...

Todo: Add description.

Required settings

The following sections are required in the smartmatrix: section of your config:

port:

Single value, type: string.

Todo: Add description.

baud:

New in version 0.32.

TODO

Optional settings

The following sections are optional in the smartmatrix: section of your config. (If you don't include them, the default will be used).

use_separate_thread:

Deprecated since version 0.32.

old_cookie:

New in version 0.32.

TODO

snux:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The snux: section of your config is where you. . .

Todo: Add description.

Required settings

The following sections are required in the snux: section of your config:

diag_led_driver:

Single value, type: string name of a coils: device.

Todo: Add description.

flipper_enable_driver:

Single value, type: string name of a coils: device.

Todo: Add description.

Optional settings

The following sections are optional in the snux: section of your config. (If you don't include them, the default will be used).

platform:

Single value, type: string. Default: None

Todo: Add description.

sound_player:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES
Valid in <i>shows</i>	YES

Note: This section can also be used in a show file in the sounds: section of a step.

The sound_player: section of your config is where you specify actions to perform on sounds when MPF events are received. Additional information may be found in the [sound_player](#) documentation.

Optional settings

The following sections are optional in the sound_player: section of your config. (If you don't include them, the default will be used).

action:

Single value, type: one of the following options: play, stop. Default: play

The action: setting controls what action will be performed on the specified sound. Options for action: are:

- play - The specified sound will be played. Any optional parameter values will override the sound's settings.
- stop - All currently playing and queued instances of the specified sound will stopped/canceled. Any optional parameter values will be ignored as the stop action takes no parameters. There is currently no way to stop specific instances of a particular sound while leaving others playing, but that is on the list to be implemented in a future version.
- stop_looping - Looping will be canceled for all currently playing instances of the specified sound (the sound will continue to play to the end of the current loop). In addition, any queued instances of the sound awaiting playback will be removed/canceled.
- load - Loads the specified sound or sound pool from its source file into memory to prepare it to be played. The request is ignored if the sound is already loaded.
- unload - Unloads the specified sound or sound pool from memory. All instances of the sound or sound pool will be immediately stopped. The request is ignored if the sound is not currently loaded.

Other available optional settings:

Several other settings may be used in the sound player to override settings specified in the `sounds:` section of config files. Please refer to the [sounds:](#) documentation for details about each setting.

- `loops:`
- `priority:`
- `max_queue_time:`
- `volume:`
- `fade_in:`
- `fade_out:`
- `start_at:`
- `events_when_played:`
- `events_when_stopped:`
- `events_when_looping:`
- `mode_end_action:`

Express configuration

When referencing sounds in the sound player, there is an alternative syntax to specify a sound when you don't wish to provide any additional settings. This shortcut notation is known as the “express configuration” and for the sound player it is simply the name of the sound asset. It can be used in both configuration files and show steps. In the config file example above, `play_sound_slingshot: slingshot_01` is an example using the express configuration (sound name only).

Sound behavior upon mode (or show) stop

When the mode or show stops that contains a `sound_player`, all sounds started in that mode or show will continue to play and stop automatically when they reach their end. Sounds that are looping will have their looping stopped so the sound will no longer continue to loop and will stop when they reach their end. Sounds that are pending playback and are queued will be canceled (removed from the queue) and will not be played. If you need a sound to be stopped immediately when a mode or show ends, you will need to add an entry in the `sound_player` to trigger a stop action based on the mode or show stop event.

sound_pools:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES

The `sound_pools:` section of your config is where you specify pools (or groupings) of sound assets in your machine.

Creating a sounds pool allows you to reference a group of sound variations as if it were a single sound. A sound pool name may be used anywhere a sound asset name may appear. Pools can be used for random differences in a sound (such as slight variations of a slingshot sound) or for an ordered sequence of sounds that will repeat. Another common use for sound pools is to play a random callout from a defined list when triggered. (Sound pools are part of the MPF media controller and only available if you're using MPF-MC for your media controller.)

Here's an example of a typical `sound_pool` configuration.

```
sound_pools:
  drain_callout:
    type: random_force_all
    sounds:
      - drain_01
      - drain_02
      - drain_03
      - drain_04
  slingshot:
    load: preload
    type: random
    sounds:
      - slingshot_01|5
      - slingshot_02|3
      - slingshot_03|2
  target_completion:
    load: on_demand
    type: sequence
    sounds:
      - target_completion_01
      - target_completion_02
      - target_completion_03
```

To create a sound pool, add a sub entry to the `sound_pools:` section of your config which will be the name of that sound pool. The name must be unique among all sound pools *and* sound assets. In the above example `drain_callout:`, `slingshot:` and `target_completion:` are each a sound pool name. Then create one or more of the following settings for each sound pool:

Required settings

The following sections are required for each named sound pool in your config:

sounds:

The `sounds:` section contains an indented list of existing sound assets (one per line) that will be contained in the sound pool. It is suggested you use block sequence notation for this list (begin each line with a dash followed by a space - ``). Optionally, a number may be appended to the sound asset name delimited by a pipe (``|) character. This optional number controls the relative weighting for random item selection, or the number of times to play the sound before moving to the next sound in the pool with a sequence pool. If no weight value is provided, a default value of 1 will be applied. In the example above, the `slingshot:` random sound pool contains relative weighting values. The weights sum to 10 for the three sounds so the `slingshot_01` sound has a probability of being randomly selected of 5 out of 10 (50%), `slingshot_02` 3/10 (30%), and `slingshot_03` 2/10 (20%).

Note: If you want to use a sound that has spaces in its name, the name of the sound must be in quotes:

```
sound_pools:
drain_callout:
  type: random_force_all
  sounds:
    - drain_01
    - drain_02
    - "drain 03" # example of a sound with a space in its name using quotes
    - drain_04
```

Optional settings

The following sections are optional for each named sound pool in your config. (If you don't include them, the default will be used).

load:

Single value, type: one of the following options: preload, on_demand. Default: on_demand

This controls the timing of when the sound assets in the sound pool will be loaded into memory (see the documentation on ([Managing Assets](#) for an explanation of what loading is). Options for load: are:

- preload - The asset is loaded when MPF boots and stays in memory as long as MPF is running.
- on_demand - The asset is loaded "on demand" when it's first called for. At this point, assets loaded on demand stay in memory forever, but at some point we'll change that so they can be unloaded on demand too.

type:

Single value, type: one of the following options: sequence, random, random_force_next, random_force_all. Default: sequence

The type: of sound pool dictates how the next sound in the pool will be selected when the sound pool is referenced for playback. Options for type: are:

- sequence - Sounds are selected in the order in which they appear in the sounds: section. An optional number/weight appended after each sound controls how many times the sound will be played before the next one in the list is selected. The sequence of sounds will repeat once all sounds have been played.
- random - Sounds are randomly selected from the list of sounds in the sounds: section of the sound pool. The probability of selecting each sound in the list can be controlled by an optional numeric weight value appended after each sound. This weight value is relative to all other sounds in the list.
- random_force_next - Sounds are randomly selected from the list of sounds in the sounds: section of the sound pool. This sound pool type ensures that the next sound selected will not be the same as the previously selected sound (no back-to-back repeats of a single sound). The probability of

selecting each sound in the list can be controlled by an optional numeric weight value appended after each sound. This weight value is relative to all other sounds in the list.

- `random_force_all` - Sounds are randomly selected from the list of sounds in the `sounds:` section of the sound pool. This sound pool type ensures that all sounds in the list will be played once before any sound will be repeated. The probability of selecting each sound in the list can be controlled by an optional numeric weight value appended after each sound. This weight value is relative to all other sounds in the list.

`simultaneous_limit:`

Single value, type: integer. Default: None

The numeric value indicating the maximum number of instances of this sound pool that may be played at the same time (up to the limit of the track). Once the maximum number of instances has been reached, the `stealing_method` setting determines the how additional requests to play the sound pool will be managed. This setting is useful for sounds that can be triggered in rapid succession (such as spinners and pop bumpers). Setting a limit will ensure a reasonable number of instances will be played simultaneously and not overwhelm the audio mix. The default value of None indicates no limits will be placed on the number of instances of the sound pool that may be played at once up to the limit of the track.

Note: The sounds contained in a sound pool can also have their own `simultaneous_limit` setting which can lead to some unexpected behavior when interacting with the `simultaneous_limit` setting in the sound pool.

`stealing_method:`

Single value, type: one of the following options: `oldest`, `newest`, `skip`. Default: `oldest`

The `stealing_method:` of a sound pool determines the behavior of additional requests to play the sound pool once the number of simultaneous instances of the sound has reached its `simultaneous_limit` limit. This setting is ignored when `simultaneous_limit` is set to None. Options for `stealing_method:` are:

- `oldest` - Steal/stop the oldest playing instance of the sound and replace it with a new instance (essentially restarts the oldest playing instance).
- `newest` - Steal/stop the newest playing instance of the sound and replace it with a new instance (essentially restarts the newest playing instance).
- `skip` - Do not steal/stop any currently running instances of the sound. Simply skip playback of the newly requested instance.

`sound_system:`

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The `sound_system:` section of your machine config controls the general settings for the machine's sound system. (This section is part of the MPF media controller and only available if you're using MPF-MC for your media controller.)

Here's an example of a typical sound configuration.

```
sound_system:
  buffer: 1024
  channels: 1
  enabled: True
  frequency: 44100
  master_volume: 0.75
  tracks:
    music:
      simultaneous_sounds: 1
      volume: 0.5
    voice:
      simultaneous_sounds: 1
      volume: 0.7
    sfx:
      simultaneous_sounds: 8
      volume: 0.4
```

Optional settings

The following sections are optional in the `sound_system:` section of your config. (If you don't include them, the default will be used). If you omit the `sound_system:` section completely, the sound configuration will contain nothing but the default values, which includes a single audio track named `default`. It is recommended that you at least specify the `tracks:` section in your machine.

buffer:

Single value, type: integer. Default: 2048

This is the size of your sound buffer. It must be a power of 2. The exact value you should use may take some trial-and-error. A bigger buffer means that there's less chance of skipping and dropout (lower CPU usage), but it also means that sounds can take longer to play since the buffer has to fill first. Some limited power platform have to run with a buffer of 4096 or 8192 or 16384, others at 512 or 256. So just play with it and see what works for you.

channels:

Single value, type: integer. Default: 1

The number of channels the sound system will support. 1 for mono, 2 for stereo. You're probably thinking, "aww man, I need stereo sound!" But almost no pinball machines do this since the speakers in the backbox are 2 feet apart and they're 4 feet away from the player's ears. (Maybe if you're going to use headphones or put tweeters in the front of the machine?) Again, if you have a resource-constrained system, then go for mono and make sure all your sound files are mono. If not, meh, go ahead and use stereo.

enabled:

Single value, type: boolean (Yes/No or True/False). Default: True

Indicates whether or not the sound system will be enabled in your machine.

frequency:

Single value, type: integer. Default: 44100

How many sound samples per second you want. 44100 is so-called “CD quality” audio, though with the sound systems in most pinball machines, if you cut it in half (to 22050) it still sounds virtually the same. If you’re running on a resource-constrained host computer, you should make sure all your sound files are encoded at the same rate so MPF doesn’t waste time re-encoding them on the fly. Smaller values mean smaller sound files, less memory consumption, and less CPU processing. So if you’re on a resource constrained host computer, think about 22050 instead of 44100. (But be sure to resample all your sound files to match.)

master_volume:

Single value, type: gain setting (*Instructions for entering gain values*) -inf, db, or float between 0.0 and 1.0. Default: 0.5

The overall volume of the MPF sound system. As with all volume parameters in MPF, this item can be represented as a number between 0.0 and 1.0 (1.0 is max volume, 0.0 is off, 0.9 is 90%, etc.) It also can be represented as a decibel string from -inf to 0.0 db (ex: -3.0 db). Note that this only controls the volume of the MPF app, not the host OS’s system volume. So you still need to make sure that the host OS is not on mute and that the volume is turned up.

tracks:

Every sound that’s played in MPF is played on a track. If you are familiar with an audio mixer a track can be thought of as a mixer channel. Each track can have it’s own settings, and you can set volume on a per-track basis. You can have up to 8 audio tracks in your MPF machine. The example above shows three tracks, called *music*, *voice*, and *sfx*. The idea (in case it isn’t obvious) is that you play all your music clips on the music track, voice callouts on the voice track, and the sound effects on the sfx track. To create a track, add a sub entry to the *tracks:* section which will be the name of that track. (So again, *music:*, *voice:* and *sfx:* in the example. Then create one or more of the following settings for each track:

Optional settings

The following sections are optional in the *tracks:* section of your config. (If you don’t include them, the default will be used).

simultaneous_sounds:

Single value, type: integer (between 1 and 32). Default: 8

This sets the maximum number of simultaneous sounds that can be played on this track. The example config file above shows the *music* and *voice* tracks with a max of 1 simultaneous sound playing, since if you have two music clips or voice callouts playing at the same time, it will sound like gibberish. A sound effects track, on the other hand, can probably have a few sounds playing at once. Note that MPF gives you detailed control over what happens if a new sound wants to play when the max simultaneous sounds are already playing on that track. Should the new sound break in and stop an existing sound? Should it wait until the existing sound is done? How long should it wait? You can control all this on a per sound basis (see the [sounds:](#) documentation for more information).

volume:

Single value, type: gain setting ([Instructions for entering gain values](#)) -inf, db, or float between 0.0 and 1.0. Default: 0.5

This is the volume setting for this track (how loud will it be), as either a value between 0.0 and 1.0 or a decibel value between -inf and 0.0 db. Note that each track's volume will be combined with the overall system volume. So if your MPF master volume is set to 0.8 (80%) and you have a track set to 0.5 (50%), sounds on that track will play at 40% overall volume (50% of 80%).

events_when_played:

New in version 0.32.

List of one (or more) values, each is a type: string. Default: None

A list of one or more names of events that MPF will post when the track is played or resumed after being stopped/paused. Enter the list in the MPF config list format. These events are posted exactly as they're entered.

events_when_stopped:

New in version 0.32.

List of one (or more) values, each is a type: string. Default: None

A list of one or more names of events that MPF will post when the track is stopped. Enter the list in the MPF config list format. These events are posted exactly as they're entered.

events_when_paused:

New in version 0.32.

List of one (or more) values, each is a type: string. Default: None

A list of one or more names of events that MPF will post when the track is paused. Enter the list in the MPF config list format. These events are posted exactly as they're entered.

sounds:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES

The `sounds:` section of your config is where you configure non-default parameter values for any sound assets you want to use in your game. Note: You do *not* have to have an entry for every single sound you want to use, rather, you only need to add individual assets to your config file that have settings which differ from other assets in that asset's folder. (This section is part of the MPF media controller and only available if you're using MPF-MC for your media controller.)

MPF-MC currently supports 16-bit Wave (.wav), Ogg Vorbis (.ogg), and FLAC (.flac) files.

Here's an example:

```
sounds:
  extra_ball:
    file: extra_ball_12753.wav
    events_when_stopped: extra_ball_callout_finished
    streaming: False
    track: voice
    volume: -4.5 db
    priority: 50
    max_queue_time: None
    ducking:
      target: music
      delay: 0
      attack: 0.3 sec
      attenuation: -18db
      release_point: 2.0 sec
      release: 1.0 sec
  slingshot_01:
    volume: 0.5
    max_queue_time: 0
```

Optional settings

The following sections are optional in the `sounds:` section of your config. (If you don't include them, the default will be used).

`events_when_played:`

List of one (or more) values, each is a type: string. Default: None

A list of one or more names of events that MPF will post when this sound is played. Enter the list in the MPF config list format. These events are posted exactly as they're entered.

`events_when_stopped:`

List of one (or more) values, each is a type: string. Default: None

A list of one or more names of events that MPF will post when this sound stops playing. Enter the list in the MPF config list format. These events are posted exactly as they're entered. These events can be useful to trigger some action when a callout has finished playing.

events_when_looping:

List of one (or more) values, each is a type: string. Default: None

A list of one or more names of events that MPF will post when this sound loops back to the beginning while playing. Enter the list in the MPF config list format. These events are posted exactly as they're entered.

file:

Single value, type: string. Default: None

Sometimes you might want to name a file one thing on disk but refer to it as another thing in your game and config files. In this case, you can create an `file:` setting in an asset entry. (Note the `file: extra_ball_12753.wav` setting in the example above, and note that it includes the file extension.) In this example, you would refer to that image asset as `extra_ball` even though the file is `extra_ball_12753`. You might be wondering why this exists? Why not just change the file name to be whatever you want and/or who cares what the name is? The reason this function exists is because it allows for the separation of the actual file on disk from the way it's called in the game. For example, you could use this to create two sets of assets—one for a traditional DMD and one for a color DMD—and then you could refer to the asset by its generic name throughout your configs. (In other words, you could swap out assets for different physical machine types without having to update your display code.) That said, we expect that 99% of people won't use this `file:` setting, which is fine.

loops:

Single value, type: integer. Default: 0

An integer value that controls the looping behavior of this sound. A value of 0 indicates the sound will not loop when reaching the end (also known as a “one-shot”). A value of -1 indicates the sound should loop infinitely until it is stopped. A value greater than 0 specifies the number of times the sound should loop back to the beginning while playing. Note that this value is not the total number of times the sound is played, but the number of times it should play again after the first time through.

priority:

Single value, type: integer. Default: 0

The numeric value indicating the priority or importance of this sound. Sounds with higher priority values will preempt other sounds with lower priorities that are playing when a track has reached the maximum number of simultaneous sounds it is configured to play. If the track is busy and the priorities of all sounds currently playing greater than or equal to this sound, the sound will be queued for playback and will have to wait to be played.

max_queue_time:

Single value, type: time string (secs) (*Instructions for entering time strings*). Default: None

Specifies the maximum time this sound can be queued before it's played. If the time between when this sound is requested and when MPF can actually play it is longer than this queue time, then the

request is discarded and the sound doesn't play. This only comes into play if this sound is requested but the track it's playing on is at its `simultaneous_sounds` limit. Then if this sound doesn't have a high enough priority to kill any of the existing sounds, it will be queued to play later. Some sounds (like voice callouts) might be ok to queue, but other sounds (like sound effects for when you hit a pop bumper or slingshot) might only make sense if they're played right away, so in those cases you might want to use a short (or no) queue time. The default setting is "None" which means this sound will have no queue limit and will always play eventually.

streaming:

New in version 0.32.

Single value, type: boolean (Yes/No or True/False). Default: False

Indicates whether or not the sound will be streamed (rather than stored in memory). Streaming sounds are limited to a single instance of the sound playing at a time. Multiple different streaming sounds may be played simultaneously, just not more than a single instance of a particular sound. When streaming is set to False, the `simultaneous_limit` setting is ignored and a value of 1 is used.

simultaneous_limit:

New in version 0.31.

Single value, type: integer. Default: None

The numeric value indicating the maximum number of instances of this sound that may be played at the same time (up to the limit of the track). Once the maximum number of instances has been reached, the `stealing_method` setting determines the how additional requests to play the sound will be managed. This setting is useful for sounds that can be triggered in rapid succession (such as spinners and pop bumpers). Setting a limit will ensure a reasonable number of instances will be played simultaneously and not overwhelm the audio mix. The default value of None indicates no limits will be placed on the number of instances of the sound that may be played at once up to the limit of the track. The value of this setting is ignored when the `streaming` setting has a value of False.

stealing_method:

New in version 0.31.

Single value, type: one of the following options: oldest, newest, skip. Default: oldest

The `stealing_method` of a sound determines the behavior of additional requests to play the sound once the number of simultaneous instances of the sound has reached its `simultaneous_limit` limit. This setting is ignored when `simultaneous_limit` is set to None. Options for `stealing_method`: are:

- oldest - Steal/stop the oldest playing instance of the sound and replace it with a new instance (essentially restarts the oldest playing instance).
- newest - Steal/stop the newest playing instance of the sound and replace it with a new instance (essentially restarts the newest playing instance).
- skip - Do not steal/stop any currently running instances of the sound. Simply skip playback of the newly requested instance.

mode_end_action:

New in version 0.31.

Single value, type: one of the following options: stop, stop_looping. Default: stop_looping

The mode_end_action: setting determines what action to take when the mode that initiates the playback of the sound ends. Options for mode_end_action: are:

- stop - All currently playing and queued instances of the specified sound started by the mode will be stopped/canceled. If the fade_out parameter has a non-zero value, the sound will fade out over the specified number of seconds.
- stop_looping - Looping will be canceled for all currently playing instances of the specified sound started by the mode (the sound will continue to play to the end of the current loop). In addition, any queued instances of the sound awaiting playback will be removed/canceled.

track:

Single value, type: string. Default: None

This is the name of the track this sound will play on. (You configure tracks and track names in the [sound_system](#): section of your machine config files.)

volume:

Single value, type: gain setting ([Instructions for entering gain values](#)) -inf, db, or float between 0.0 and 1.0. Default: 0.5

The volume of this sound. This value is factored into the track and overall MPF volumes. It's used to "balance" your sounds if you have one particular sound that's too loud or too quiet. As with all volume parameters in MPF, this item can be represented as a number between 0.0 and 1.0 (1.0 is max volume, 0.0 is off, 0.9 is 90%, etc.) It also can be represented as a decibel string from -inf to 0.0 db (ex: -3.0 db).

fade_in:

New in version 0.31.

Single value, type: time string (secs) ([Instructions for entering time strings](#)). Default: 0

The number of seconds over which to fade in the sound when it is played.

fade_out:

New in version 0.31.

Single value, type: time string (secs) ([Instructions for entering time strings](#)). Default: 0

The number of seconds over which to fade out the sound when it is stopped. This value is not applied when the sound stops on its own by reaching the end of the sound (will likely be added in a future version). At the moment it only comes into play when the sound is actively stopped by an event.

start_at:

New in version 0.31.

Single value, type: time string (secs) (*Instructions for entering time strings*). Default: 0

The position in the sound file (in seconds) to start playback of the sound when it is played. When the sound is looped it will loop back to the beginning of the sound file.

ducking:

The ducking: section controls *ducking* for the sound. It contains the following nested sub-settings:

Required settings

The following sections are required in the ducking: section of your config:

target:

List of one (or more) values, each is a type: string.

The list of track names to apply the ducking to when the sound is played. This most commonly contains the name of the track that music is played on.

attack:

Single value, type: time string (secs). Default: 10ms

The duration of the period over which the ducking starts until it reaches its maximum attenuation (attack stage). This value is specified as a *time string*.

Optional settings

The following sections are optional in the ducking: section of your config. (If you don't include them, the default will be used).

attenuation:

Single value, type: gain setting (*Instructions for entering gain values*) -inf, db, or float between 0.0 and 1.0. Default: 1.0

The attenuation (gain) to apply to the target track while ducking. attenuation: controls how quiet to make the target track while the sound is playing.

release:

Single value, type: time string (secs). Default: 10ms

The duration of the period over which the ducking goes from its maximum attenuation until the ducking ends (release stage). This value is specified as a *time string*.

release_point:

Single value, type: time string (secs). Default: 0

The point relative to the end of the sound at which to start the returning the attenuation back to normal (release stage). A value of 0.5 seconds means to begin to release the ducking 0.5 seconds prior to the end of the sound. This value is specified as a *time string*.

Optional settings

The following sections are optional in the ducking: section of your config. (If you don't include them, the default will be used).

delay:

Single value, type: time string (secs). Default: 0

The duration to delay after the sound starts playing before ducking starts. This value is specified as a *time string*.

markers:

New in version 0.31.

The markers: section establishes a list of markers and their associated events at specific times in the sound. When a marker is reached during playback, the associated events will be posted. Markers are useful for synchronizing various actions with specific points in a sound. A typical use might be to send an 'almost_finished_playing' event a short time before a sound finishes playback or establish various checkpoints in a sound that could be used to restart a sound at that point on the user's next turn (using mode code).

Here's a simple example utilizing markers:

```
sounds:
  long_sound_1:
    volume: 0.8
    markers:
      - time: 2.534 sec
        events: send_this_event, also_this_event
      - time: 6.712 sec
        events: almost_finished_playing
```

The markers: section contains the following settings:

time:

Single value, type: time string (secs).

The marker time (in seconds) relative to the beginning of the sound file.

events:

List of one (or more) values, each is a type: string. Default: None

A list of one or more names of events that MPF will post when this marker is reached during sound playback. Enter the list in the MPF config list format. These events are posted exactly as they're entered.

spike:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The spike: section of your machine-wide config is where you configure hardware options that are specific to the SPIKE interface when you're using MPF with a Stern SPIKE machine. Note that we have a how to guide which includes *all the SPIKE-specific settings* throughout your entire config file, so be sure to read that if you have a SPIKE machine.

```
hardware:
  platform: spike

spike:
  port: /dev/ttyUSB0
  baud: 115200
  debug: False
  nodes: 0, 1, 8, 9, 10, 116
```

Required Settings

The following sections are required in the spike: section of your config:

port:

Use the port of your USB-serial adapter or of the internal serial on the RPi.

baud:

This needs to match the value from Step 3 in the MPF SPIKE bridge instructions.

nodes:

Configure the nodes from your manual. Note that there should always be a node 0 and 1.

Optional Settings

The following sections are optional in the `spike:` section of your config. (If you don't include them, the default will be used).

debug:

Set to true for troubleshooting to print more details in the log. Default is False.

poll_hz:

Numeric value of how many times per second MPF will poll the SPIKE system to check for switch changes. Default is 1000.

connection:

Default is shell

TODO

switch_overwrites:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The `switch_overwrites:` section of your config is where you...

Todo: Add description.

Optional settings

The following sections are optional in the `switch_overwrites:` section of your config. (If you don't include them, the default will be used).

debounce:

Single value, type: one of the following options: quick, normal, None. Default: None

Todo: Add description.

switch_player:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The switch_player: section of your config is where you...

Todo: Add description.

Optional settings

The following sections are optional in the switch_player: section of your config. (If you don't include them, the default will be used).

start_event:

Single value, type: string. Default: machine_reset_phase_3

Todo: Add description.

switches:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The switches: section of the config files is used to map switch names to controller board inputs. You can map both direct and matrix switches. Here's an example section:

```
switches:
  flipper_lwr_eos:
    number: SF1
  flipper_lwr:
    number: SF6
```



```
fire_r:
  number: S12
  tags: plunger
start:
  number: S13
  tags: start
plumbbob:
  number: S14
  tags: tilt
outlane_l:
  number: S16
  tags: playfield_active
  debounce: slow
inlane_l:
  number: S17
  tags: playfield_active
  debounce: quick
trough1:
  number: S81
  type: 'NC'
shooter_lane:
  number: S82
  events_when_activated: ball_in
  events_when_deactivated: ball_out
```

Each subsection of `switches:` is a switch name, which is how you refer to the switch in your game code. Then there are several parameters for each switch:

Required settings

The following sections are required in the `switches:` section of your config:

number:

Single value, type: string.

This is the number of the switch which specifies which switch input the switch is physically connected to. The exact format used here will depend on which control system you're using and how the switch is connected.

See the [How to configure “number:” settings](#) guide for details.

Optional settings

The following sections are optional in the `switches:` section of your config. (If you don't include them, the default will be used).

debounce:

Single value, type: one of the following options: auto, quick, normal. Default: auto

Todo: Add description.

debug:

Single value, type: boolean (Yes/No or True/False). Default: False

Todo: Add description.

events_when_activated:

List of one (or more) values, each is a type: string. Default: None

A list of one or more names of events that MPF will post when this switch goes active. These events are posted exactly as they're entered, in addition to any events that are posted based on the switch's tags.

events_when_deactivated:

List of one (or more) values, each is a type: string. Default: None

A list of one or more names of events that MPF will post when this switch goes inactive.

ignore_window_ms:

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: 0

Specifies a duration of time during which additional switch activations will be ignored.

For example, if you set ignore_window_ms: 100, then a switch is activated once, then again 50ms later, the second activation will be ignored. The timer is set based on the last switch hit that *activated* the switch, so if another switch hit came in 105ms after the first (which would be 55ms after the second), it will also count.

label:

Single value, type: string. Default: %

Todo: Add description.

platform:

Single value, type: string. Default: None

Name of the platform this switch is connected to. The default value of None means the default hardware platform will be used. You only need to change this if you have multiple different hardware platforms in use and this coil is not connected to the default platform.

See the [Mixing-and-Matching hardware platforms](#) guide for details.

tags:

List of one (or more) values, each is a type: string. Default: None

You can add tags to switches to logically group them in your game code to make it easier to do things. (Like “if all the switches tagged with droptarget_bank1 are active, then do something.”) Tags are also used to create MPF events which are automatically posted with an sw_ prefix, by tag, when a switch is activated. For example, if you have a switch tagged with “hello”, then every time that switch is activated, it will post the event sw_hello. If you have a switch tagged with “hello” and “yo”, then every time that switch is activated it will post the events sw_hello and sw_yo. MPF also makes use of several tags on its own, including:

- playfield_active - This tag should be used for all switches on the playfield that indicate a ball is loose on the playfield. This tag is used by the playfield to know that balls are on it. Note that if you have more than one playfield, the tag name is (playfield_name)_active, so if you have a playfield called “upper playfield”, you’d tag the switches on that playfield with “upper_playfield_active”.
- start - Let’s MPF know that this switch is used to start a game. (Note that in MPF, the game start process is kicked off when this switch is released, not pressed, which allows the “time held down” to be sent to MPF to perform alternate game start actions.)

type:

Single value, type: one of the following options: NC, NO. Default: NO

You can add NC as a type (like type: NC) to indicate that this switch is a normally closed switch, i.e. it’s closed when it’s inactive and open when it’s active. This is mostly used for optos.

Switches which are type NC are automatically inverted by the Switch Controller. In other words an NC switch is still “active” when it’s being activated, but the Switch Controller knows that activation actually occurs when the switch opens, rather than closes. Setting the type to NC here means that you never have to worry about this inversion anywhere else in your game code.

system11:

Config file section

Valid in machine config files	YES
Valid in mode config files	NO

The system11: section of your config is where you...

Todo: Add description.

Required settings

The following sections are required in the `system11:` section of your config:

`ac_relay_driver:`

Single value, type: string name of a coils: device.

Todo: Add description.

Optional settings

The following sections are optional in the `system11:` section of your config. (If you don't include them, the default will be used).

`ac_relay_delay_ms:`

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: 75ms

Todo: Add description.

`text_strings:`

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES

The `text_strings:` section of your config is where you...

Todo: Add description.

`tilt:`

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES

The `tilt:` section of your config is where you...

Todo: Add description.

Optional settings

The following sections are optional in the `tilt:` section of your config. (If you don't include them, the default will be used).

`multiple_hit_window:`

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: 300ms

Todo: Add description.

`reset_warnings_events:`

Changed in version 0.31.

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the *Device Control Events* documentation for details on how to enter settings here.

Default: ball_will_end

These events, when posted, will cause the `warnings_to_tilt:` to be reset to zero.

`settle_time:`

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: 5s

Todo: Add description.

`slam_tilt_switch_tag:`

Single value, type: string. Default: slam_tilt

Todo: Add description.

`tilt_events:`

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the *Device Control Events* documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, cause a *tilt* to occur which will end the current ball in progress with no end of ball bonus.

tilt_slam_tilt_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the *Device Control Events* documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, cause a *slam_tilt* event to be posted. The slam tilt typically ends the current game and also clears all credits from the machine.

tilt_switch_tag:

Single value, type: string. Default: tilt

Todo: Add description.

tilt_warning_events:

One or more sub-entries, either as a list of events, or key/value pairs of event names and delay times. (See the *Device Control Events* documentation for details on how to enter settings here.

Default: None

Events in this list, when posted, cause a tilt warning to occur. They will post the *tilt_warning* event, and if the warnings_to_tilt: limit is hit, will also cause the *tilt* event.

tilt_warning_switch_tag:

Single value, type: string. Default: tilt_warning

Todo: Add description.

tilt_warnings_player_var:

Single value, type: string. Default: tilt_warnings

Todo: Add description.

warnings_to_tilt:

Single value, type: integer. Default: 3

Todo: Add description.

timed_switches:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

New in version 0.33.

Specifies *timed switches* which are used to post events when a switch is active for a continuous amount of time.

Here's an example. This example is actually built-in to MPF via the MPF default config file, so if you want to use these flipper cradle events, you don't have to enter them yourself as they're already there.

```
timed_switches:
  flipper_cradle:
    switch_tags: left_flipper, right_flipper
    time: 3s
    events_when_active: flipper_cradle
    events_when_released: flipper_cradle_release
```

Like other devices in MPF, the format is:

```
timed_switches:
  name_of_your_timed_switch:
    <settings>
  some_other_timed_switch:
    <settings>
```

Settings

The following settings can be used in each named timed switch section:

switches:

A list of switches (or a single switch) that will be used for these timed switch settings. Note that you can use `switch_tags:` instead of `switches:`.

switch_tags:

A list of switch tags (or a single tag) that will be used to set which switches are used with these timed switch settings. Each switch with these tags will be added.

time: (required)

Single value, type: time string (*Instructions for entering time strings*).

How long a switch must be continuously active before the events_when_active are posted.

state:

Single value, either active or inactive. Default is active.

Controls whether the events_when_active: are posted when the switch is active for the time: amount, or whether it's flipped and the events are posted when the switch is inactive for the time amount.

events_when_active:

A single event, or list of events, that's posted once a switch is continuously active for the time: setting. If you have multiple switches, this event will only be posted once, even if a second switch becomes active for that time while the first is still active.

If you don't enter any events here, an event will automatically be posted in the format `<name_of_this_timed_switch>_active`. In other words, in the example at the top of this page, the timed switch entry is called "flipper_cradle", so the automatically-created event would be called `flipper_cradle_active`, but since that config has an events_when_active: flipper_cradle entry, then the event will just be `flipper_cradle`.

events_when_released:

A single event, or list of events, that will be posted when a timed switch is released. Unlike the active events which are only posted when the switch is continuously active for that period of time, the released events are posted immediately.

If you've defined multiple switches and two switches go active, the release event will not be posted until all the switches are released.

timers:

Config file section

Valid in <i>machine config files</i>	NO
Valid in <i>mode config files</i>	YES

The timers: section of your config is where configure timers that can "tick" up or down. Timers post events with each tick which you can use to update slides, etc. You can set the start and stop values of the timers, as well as how fast they tick, how much they change per tick, and other settings.

The settings structure of timers is like this:

```
timers:
  timer_name:
    <settings>
```



```

some_other_timer_with_a_different_name:
  <settings>
a_third_timer:
  <settings>

```

Here's an example timers: section from the "Money Bags" mode in *Brooks 'n Dunn* which contains two timers:

```

timers:
  mb_intro_timer:
    start_value: 3
    end_value: 0
    direction: down
    control_events:
      - action: start
        event: mode_money_bags_started
  money_bags_timer:
    start_value: 15
    end_value: 0
    direction: down
    tick_interval: 1.25s
    control_events:
      - action: start
        event: timer_mb_intro_timer_complete
      - action: add
        event: money_bags_advertise_flashing_hit
        value: 5
      - action: stop
        event: logicblock_money_bags_counter_complete

```

In the example above, an intro timer which runs for 3 seconds is started by the event *mode_money_bags_started* (which means this timer starts when the mode starts). A second timer (the "money_bags_timer") starts when the intro timer is complete. It starts with a value of 15 and counts down to 0 (but at a count interval of 1.25 seconds so it's a bit slower than real time. It will also get reset back to 15 each time a flashing shot is hit.

Here's another example of timers from *Demo Man's* skillshot mode:

```

timers:
  mode_timer:
    start_value: 3
    end_value: 0
    direction: down
    tick_interval: 1s
    control_events:
      - event: balldevice_playfield_ball_enter
        action: start
      start_running: false
  target_rotator:
    start_running: true
    tick_interval: 1s

```

The skillshot mode starts when the ball is waiting to be plunged. The timer called "mode_timer" in the example above starts when the ball enters the playfield and runs for 3 seconds. If it runs all the way down, the skill shot mode will stop (meaning the player missed the skillshot).

A second timer doesn't have any count values associated with it, rather it just "ticks" once a second. That tick event is used to rotate the lit skillshot.

Settings

Individual timers can use the following options:

bcp:

THIS OPTION HAS BEEN REMOVED IN 0.33

Single value, type: boolean (Yes/No or True/False). Default: False

Controls whether the various timer events (count, start, stop, complete, etc.) are sent to the MPF-MC via BCP.

TODO: Remove from documentation

control_events:

List of one (or more) values, each is a type: sub-configuration containing control_events settings.

Default: None

Timer control events is where you specify what happens to this timer when other events are posted.

They're entered as a list (with dashes) under the control_events: section. All control events have an event: and action: setting. (When the "event" is posted, the "action" is taken. Some actions require an additional value: setting. For example, for the "add" action which adds time, you need to specify how much time you want to add. But other actions, like "start" or "stop" don't need values.

Take a look at the various types of actions you can perform on timers with control events:

Options:

add Adds the time (specified in the value: setting) to the timer. If the value would be higher than the timer's max_value: setting, then the value is set to the max value. Posts the *timer_<name>_time_added* event.

This action does not change the timer's running state.

The timer is checked for done after the value has been added. (So, for example, if you have a timer that's set to count up, and the timer finishes at 10, and the timer is currently at 6, and you add value of 5, then the timer will be complete.

subtract Subtracts time (specified in the value: setting) from the timer. Posts the *timer_<name>_time_subtracted* event and checks to see if the timer is complete.

jump "Jumps" the timer to a specific new value (specified in the value: setting) and checks to see if the timer is complete.

start Starts the timer if it's not running. Does nothing if the timer is already running. Posts the *timer_<name>_started* event.

stop Stops the timer and posts the *timer_<name>_stopped* event. Removes any outstanding "pause" delays.

reset Changes the timers current value back to the `start_value:`. Nothing else is touched, so if the timer is running, it stays running, etc.

restart Acts as a combination of `reset`, then `start`.

pause Pauses the timer for a given value: time (in seconds). Note that the timer pause value is real world seconds and does not take the timers tick interval into consideration. If the pause value is 0, the timer is paused indefinitely. Posts the `timer_<name>_paused` event.

set_tick_interval Sets the tick interval to a new value (specified in the value: setting).

change_tick_interval Changes the tick interval by multiplying the current tick interval by the new one specified in the value: setting. In other words, if you want to make the tick interval 10% faster, than set this to value: 1.1. If you want to make it 50% slower, set this to value: 0.5, etc.

reset_tick_interval (added in MPF 0.33)

Resets the timer's tick interval back to the original from the `tick_interval:` setting.

Here's an example of control events in action:

```
timers:
  my_timer:
    direction: down
    start_value: 10
    tick_interval: 125s
    control_events:
      - event: start_my_timer
        action: start
      - event: reset_my_timer
        action: reset
      - event: add_5_secs
        action: add
        value: 5
```

In the example above, when the event `start_my_timer` is posted, the timer called “my_timer” will start running. When the event `add_5_secs` is posted, 5 seconds will be added to whatever the current value of “my_timer” is, etc.

debug:

Single value, type: boolean (Yes/No or True/False). Default: False

If true/yes, adds additional logging information to the verbose log for this timer.

direction:

Single value, type: string. Default: up

Controls which direction this timer runs in. Options are up or down.

end_value:

Single value, type: integer. Default: None

Specifies what the final value for this timer will be. When the timer value equals or exceeds this (for timers counting up), or when it equals or is lower than this (for timers counting down), the *timer_<name>_complete* event is posted and the timer is stopped. (If the *restart_on_complete*: setting is true, then the timer is also reset back to its *start_value*: and started again.)

Note that you can use a *dynamic value* for this setting.

max_value:

Single value, type: integer. Default: None

The maximum value this timer can be. If you try to add value above this, the timer's value will be reset to this value.

restart_on_complete:

Single value, type: boolean (Yes/No or True/False). Default: False

Controls what should happen when this timer completes. If you have *restart_on_complete*: true, then this timer will reset back to the *start_value* and start again after it completes.

start_running:

Single value, type: boolean (Yes/No or True/False). Default: False

Controls whether this timer starts running ("started"), or whether it needs to be started with one of the start control events.

start_value:

Single value, type: integer. Default: 0

The initial value of the timer.

Note that you can use a *dynamic value* for this setting.

tick_interval:

Single value, type: time string (ms) (*Instructions for entering time strings*) . Default: 1s

A time value for how fast each tick is. The default is 1 second, but quite often "pinball time" is slower than real world time, and a countdown timer will actually tick a speed that's slower than 1 second per tick. (So in that case, you might set *tick_interval*: 1.25s or something like that. You can also set this really short if you want a hurry up, maybe every 100ms removed 77,000 worth of points or something.

Note: This is a template setting

track_player:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES
Valid in <i>shows</i>	YES

Note: This section can also be used in a show file in the tracks: section of a step.

The track_player: section of your config is where you specify actions to perform on audio tracks when MPF events are received. Tracks can be stopped, paused, or played with an optional fade time. The volume of a track can also be changed with an optional fade time. Finally, all sounds currently playing on a track can be stopped (again with an optional fade out time). (This player is part of the MPF media controller and only available if you're using MPF-MC for your media controller.)

See the *config player* for more information on config players.

New in version 0.32.

Usage in config files

In config files, the track player is used via the track_player: section. Event names that will trigger track actions are nested sub-headings and track names are listed as nested sub-headings below that. `__all__` can be used in place of a track name to apply the action to all audio tracks in the sound system.

Example:

```
track_player:
  pause_music_track:
    music:
      action: pause
      fade: 1 sec
  resume_music_track:
    music:
      action: play
  stop_sounds_on_all_tracks:
    __all__:
      action: stop_all_sounds
      fade: 0.5 sec
```

Usage in shows

In shows, the track player is used via the tracks: section of a step.

Example:

```
shows:
  my_show_with_sound:
    - time: 0
```



```
    tracks:
      music:
        action: set_volume
        volume: 0.3
        fade: 0.25 sec
- time: 3.5
  tracks:
    music:
      action: set_volume
      volume: 0.5
      fade: 0.25 sec
```

Required settings

The following sections are required for each named sound pool in your config:

action:

Single value, type: one of the following options: play, stop, pause, set_volume, stop_all_sounds.
Default: None

The action: setting controls what action will be performed on the specified track. Options for action: are:

- play - The specified track will be played after it has been stopped or paused.
- stop - The track is stopped (with an optional fade out time). All sound processing on the track is stopped and the track is cleared. All playing and queued sounds are canceled. All sound events on the track are ignored/discarded while the track is stopped.
- pause - The track is paused (with an optional fade out time). All sound processing on the track is paused. The track will pick-up where it left off when played/resumed. All sound events on the track are ignored/discarded while the track is paused.
- set_volume - Set a new volume level for the track (with an optional timed fade from the current volume level).
- stop_all_sounds - Stops all sounds currently playing on the track (with optional fade out time) and cancels any pending sounds in the track sound queue. The fade_out setting for any playing sounds will be ignored. The track will continue to process new sound events.

Optional settings

volume:

Single value, type: gain setting (*Instructions for entering gain values*) -inf, db, or float between 0.0 and 1.0. Default: 0.5

The new volume setting for the track. As with all volume parameters in MPF, this item can be represented as a number between 0.0 and 1.0 (1.0 is max volume, 0.0 is off, 0.9 is 90%, etc.) It also can be represented as a decibel string from -inf to 0.0 db (ex: -3.0 db). This setting only applies to the set_volume action and will be ignored for all others.

fade:

Single value, type: time string (secs) (*Instructions for entering time strings*). Default: 0

The number of seconds over which to fade the specified track action. Applies to all track player actions.

Express configuration

There is no express (one line) configuration for the track player. You must specify the action setting every time.

trigger_player:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES
Valid in <i>shows</i>	YES

Note: This section can also be used in a show file in the triggers: section of a step.

The trigger_player: section of your config is where you...

Todo: Add description.

video_pools:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES

The video_pools: section of your config is where you...

Todo: Add description.

videos:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES

The `videos:` section of your config is where you configure non-default parameter values for any video assets you want to use in your game. Note: You do *not* have to have an entry for every single video you want to use, rather, you only need to add individual assets to your config file that have settings which differ from other assets in that asset's folder. (This section is part of the MPF media controller and only available if you're using MPF-MC for your media controller.)

More information on working with assets is in the [Assets](#) section of the documentation.

Optional settings

The following sections are optional in the `videos:` section of your config. (If you don't include them, the default will be used).

<name>:

Each sub-entry in your `videos:` section is the name that MPF will use to refer to that asset. (In other words it's how you specify that asset in other areas of your config files.) The asset manager works by first scanning the file system to build up a list of asset files it finds. Then it looks at the config to see if there are any additional settings specified for each asset.

For example:

```
videos:
  intro_video:
    width: 100
    height: 70
    file: mpf_video_small.mpg
```

So in the example above, if the asset manager found a file called `mpf_video_small.mpg` on disk, then it will also see the `intro_video` entry in the config file and know that those two match. (The "match" is just based on the part of the file name without the extension, so the settings entry for `intro_video:` would match `mpf_video_small.mpg` and `mpf_video_small.m4v`. In other words, don't name two files with the same name if you want to keep them straight.)

`auto_play:`

Single value, type: boolean (Yes/No or True/False). Default: True

Whether this video should start playing automatically when it's loaded.

`file:`

Single value, type: string. Default: None

Sometimes you might want to name a file one thing on disk but refer to it as another thing in your game and config files. In this case, you can create a `file:` setting in an asset entry. (Note the `file: hello_face_300.jpg` setting in the example above, and note that it includes the file extension.) In this example, you would refer to that image asset as `hello_face` even though the file is `hello_face_300`.

You might be wondering why this exists? Why not just change the file name to be whatever you want and/or who cares what the name is? The reason this function exists is because it allows for the separation of the actual file on disk from the way it's called in the game. For example, you could use

this to create two sets of assets—one for a traditional DMD and one for a color DMD—and then you could refer to the asset by its generic name throughout your configs. (In other words, you could swap out assets for different physical machine types without having to update your display code.) That said, we expect that 99% of people won't use this file: `setting`, which is fine.

load:

Single value, type: string. Default: None

Videos are always streamed from disk (rather than preloaded into memory), so this setting has no effect with video assets.

height:

Single value, type: number. Default: None

The height of this video, in pixels.

width:

Single value, type: number. Default: None

The width of this video, in pixels.

events_when_played:

New in version 0.33.

List of one (or more) values, each is a type: string. Default: None

A list of one or more names of events that MPF will post when this video is played. Enter the list in the MPF config list format. These events are posted exactly as they're entered.

events_when_stopped:

New in version 0.33.

List of one (or more) values, each is a type: string. Default: None

A list of one or more names of events that MPF will post when this video stops playing. Enter the list in the MPF config list format. These events are posted exactly as they're entered. These events can be useful to trigger some action when a video has finished playing (like remove a slide).

virtual_platform_start_active_switches:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The `virtual_platform_start_active_switches:` section of your config is where you...

Todo: Add description.

widget_player:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES
Valid in <i>shows</i>	YES

The `widget_player:` section of your config is where you configure widgets to be added to, removed from, or updated on slides based on events being posted.

Note that the widget player is a *config_player*, so everything mentioned below is valid in the `widget_player:` section of a config file *and* in the `widgets:` section of a *show step*.

Full instructions on how to use the `slide_player` are included in the *Widgets* section of the documentation. The stuff here in the config reference is for reference later.

Generically-speaking, there are two formats you can use for `widget_player` entries: “express” and “full” configs. Express configs will look like this:

```
widget_player:
  event1: widget1
  event2: widget2
  event3: widget3
```

Full configs will look like this:

```
widget_player:
  event1:
    widget1:
      <settings>
  event2:
    widget2:
      <settings>
  event3:
    widget3:
      <settings>
```

In both cases, these configurations are saying, “When *event1* is posted, add widget *widget1*. When *event2* is posted, add *widget2*. Etc.”

This “express” config is down-and-dirty, with no options, to just add widgets to the current slide on the default display. The full config lets you specify additional options (based on the settings detailed below).

For example, the following config will add *widget_1* when *some_event* is posted, but it will also override the default settings and add widget to the slide called *slide_2*, even if that’s not the current slide that’s showing.


```

widget_player:
  some_event:
    widget_1:
      slide: slide_2

```

Settings

The following sections can be added under the the a particular widget's settings widget_player: section of your config. (If you don't include any of them, the default will be used).

So again, the format in a config file would be:

```

#config_version=4

widget_player:
  some_event:
    name_of_your_widget:
      <list of settings below go here>
  some_other_event:
    name_of_a_different_widget:
      <list of settings below go here>

```

And the format in a show file would be:

```

#show_version=4

- duration: 1s
  widgets:
    name_of_your_widget:
      <list of settings below go here>
    name_of_a_different_widget:
      <list of settings below go here>

```

Here are the settings you can use:

action:

Single value, type: one of the following options: *add*, *remove*, *update*. Default: *add*

Specifies what action will take place when this event is posted.

add The widget or widget group is added to the slide or display target.

remove The widget or widget group is removed from the slide or display target.

update One or more of the widget or widget group's properties is updated.

key:

Single value, type: string. Default: None

Used to uniquely identify a widget. With "add" actions, this sets the key name, and with "remove" or "update" actions, the key is used to identify which widget should be removed or updated.

Note that more than one widget (across displays and across slides) can have the same key, and if you remove a widget based on a key, it will remove all the widgets with that key. (In fact this is how MPF works internally to remove all widgets that were created by a mode when that mode ends.)

See the [Widget Keys](#) guide for details.

slide:

Single value, type: string. Default: None

The name of the slide you want to add this widget to. If this is not specified, then the widget will be added to whichever slide is currently active on the default display.

target:

Single value, type: string. Default: None

The name of the display or slide frame this widget will be added to. When this setting is used, the widget is not added to a slide, rather, it's added "on top" of the slide (to the parent display or slide frame). See the [Widget layers, z-order, & parent frames](#) guide for details.

Note that the `target:` and `slide:` setting are fundamentally not compatible with each other. If you used both, the `target:` setting will be used and the `slide:` value will be ignored.

widget_settings:

Used to override and/or update

widget_styles:

Config file section

Valid in machine config files	YES
Valid in mode config files	YES

Note: This section can also be used in a show file in the `widgets:` section of a step.

The `widget_styles:` section of your config is where you...

Todo: Add description.

Optional settings

The following sections are optional in the `widget_styles:` section of your config. (If you don't include them, the default will be used).

color:

Single value, type: color (*color name*, *hex*, or list of values 0-255). Default: ffffffff

Todo: Add description.

Note: The widget_styles: section of your config may contain additional settings not mentioned here. Read the introductory text for details of what those might be.

widgets:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	YES

The widgets: section of your config is where you pre-define “named” widgets that you can then use later in shows and the widget_player section of a config file. (See the [Widgets](#) guide for details.)

Since there are many different types of widgets in MPF, it doesn’t make sense to list all the widget type and all the options here. Instead check out the [Widgets](#) documentation which has all the details, including config file reference for different types of widgets.

window:

Config file section

Valid in <i>machine config files</i>	YES
Valid in <i>mode config files</i>	NO

The window: section of your config is where you configure the properties of the on-screen window which is created by MPF-MC.

::

window: width: 800 height: 600 title: Mission Pinball Framework resizable: yes borderless: yes
fullscreen: no exit_on_escape: True source_display: window

Note: If you do not add a window: section to your machine config, MPF will create a window at the default size of 800x600.

Optional settings

The following sections are optional in the window: section of your config. (If you don’t include them, the default will be used).

borderless:

Single value, type: boolean (Yes/No or True/False). Default: 0

Controls whether the pop-up window has a border (the “frame”) around it.

exit_on_escape:

Single value, type: boolean (Yes/No or True/False). Default: true

Controls whether the MPF MC shuts down when the Esc key is pressed.

fullscreen:

Single value, type: boolean (Yes/No or True/False). Default: 0

Controls whether the pop-up window should be a full screen window (if the value is “true”) or whether it should be a regular window.

height:

Single value, type: integer. Default: 600

The initial height of the popup window, specified in pixels.

icon:

Single value, type: string. Default: None

The icon for the window which will be shown in the title bar.

left:

Single value, type: integer. Default: None

Used to position a non-fullscreen window in a precise location on the screen. (This is useful if you’re using an LCD display in your machine and your backbox has a smaller opening than the size of the screen. In that case you need to make sure the pop-up window always shows up in the proper location.)

The left: value specifies how many pixels the left edge of the window will be offset from the left edge of the screen. (See the top: setting to control the vertical placement.)

maxfps:

Single value, type: integer. Default: 60

Sets the maximum frames-per-second that the window is updated. Setting a lower value can potential save CPU / GPU usage.

minimum_height:

Single value, type: integer. Default: 0

If you have a resizable window, this specifies the minimum height the window can be resized to.

minimum_width:

Single value, type: integer. Default: 0

If you have a resizable window, this specifies the minimum width the window can be resized to.

no_window:

Single value, type: boolean (Yes/No or True/False). Default: False

Controls whether the pop up window is used.

resizable:

Single value, type: boolean (Yes/No or True/False). Default: 1

Specifies whether the pop-up window can be resized (by dragging an edge with the mouse). If your window is full screen, then this setting will have no effect.

show_cursor:

Single value, type: boolean (Yes/No or True/False). Default: 1

Specifies whether the mouse cursor should be drawn when the pointer is moved over the window. If you set this to False/No, then when you drag the pointer over the window, the pointer will disappear.

source_display:

Single value, type: string. Default: default

The name of the MPF display that will be used for the source content for the pop-up window.

title:

Single value, type: string. Default: Mission Pinball Framework v0.30.0

The text that's shown in the window title bar (assuming your window is not full screen and not borderless).

top:

Single value, type: integer. Default: None

Used to position the pop up window in a fixed position when MPF MC starts.

See the setting `left:` for details.

width:

Single value, type: integer. Default: 800

The initial width of the popup window, specified in pixels.

The concept of *events* is one of the most important concepts in MPF. MPF is an event-driven framework, and just about everything is either posting an event or responding to an event that was posted.

There are several important concepts about events in MPF that you should understand:

Events Overview

It's easiest to understand the concept of events by going through some examples.

For example, you might have a `scoring:` entry in your config which watches for an event called *target1_hit*, and when it sees it, it adds 1000 points to the player's score, like this:

```
scoring:
  target1_hit:
    score: 1000
```

What's really happening behind the scenes here is MPF's score system tells the event system, "Hey, if you see an event called *target1_hit*, let me know about it." (This is called "registering a handler", because the scoring system is registering with the event since that it can handle that event.)

Then later on, the switch for target 1 gets activated, and the shot controller posts the event called *target1_hit*. The Event Manager says, "Hey, I remember the scoring system wanted to know about that", so it tells the scoring system that *target1_hit* was just posted and the scoring system can wake up and deal with it (adding the points, in this case).

So really there are two parts to the events system:

- Things that generate (post) events.
- Things that take action on (handle) events.

Let's look at each of these.

Things that generate (post) events

There are hundreds of different things that post events in MPF (for all sorts of reasons). Just to pick some random examples of things that post events:

- A switch is hit
- A player variable changes
- A timer expires
- A mode stops or starts
- A new slide is shown on the display
- A ball drains
- A ball enters a ball device
- A new player's turn starts
- etc.

We actually have a giant list of all the events that are posted by everything in MPF. This is called the [event reference](#). (It's also linked from the "Reference" section in the menu on the left of every page in the docs website since it's so important.)

As you read through the rest of the documentation for various aspects of MPF, you'll see settings for things like `events_when_XX`: with the "XX" being some state.

For example, logic blocks have a setting called `events_when_hit`: where you can enter the name of an event. (In that case the name can be whatever you want, like `events_when_hit: mpf_is_awesome`, and then when that logic block is hit, it will post the event `mpf_is_awesome`, and any other components that are registered for that event will see it and take their respective action.

This means that while the event reference is useful because it shows all the *built-in* events, your machine will have lots of other events not on that list that you define.

Things that take action on (handle) events

The flip side of things that post events is things that taken action on (or "handle") events. These are the things that watch for certain event names, and then when they see them, they take action.

Some random examples:

- The game mode will look for `ball_drain` events which it will handle by ending the current player's ball.
- The scoring system might look for a shot hit event to add points to the player's score.
- A jackpot mode might look for a ramp made event to play a show which will flash some lights and display a jackpot slide.
- A mode might look for the event which comes from shooting a ball into a ball lock to start a multiball mode.
- etc.

As you'll see as you read through the MPF documentation, there are two main ways (plus a lot of little ways) to make things happen when certain events are posted:

In the various *config players* (*slide_player*, *led_player*, *show_player*, etc.), you create entries based on event names.

For example, in a config file:

```
slide_player:
  mpf_is_awesome: my_slide
```

The above config will show the slide called “my_slide” on the display when the event *mpf_is_awesome* is posted. Of course this could be any event, including one from the Events Reference list or a custom event like we discussed above.

Also, a lot of things in MPF have *XX_events*: settings, (the “XX” will be some word) which is where you can event event names that cause that action to happen. For example, you may have a drop target configured like this:

```
drop_targets:
  my_drop_target:
    switch: s_drop_target_1
    reset_coil: c_drop_target_reset
    reset_events: mpf_is_awesome
```

In this case, when the event *mpf_is_awesome* is posted, that will cause that drop target to reset. Again, this is just one random example of the literally hundreds of things that can take action on events, and these events could be from the master events list or your own custom events.

The Event Manager

One of MPF’s internal core components is called the *Event Manager*. The event manager keeps track of the hundreds of handlers that have registered for different events, and it’s what other components contact when they want to post and event.

When an event is posted, the event manager contacts the handlers to let them know that they need to take action on their event.

Luckily the complexity of the event manager is hidden from you—all you have to know is that events are posted and handlers can act on them.

Finally, here are a few more random thoughts about events in MPF:

- There are lots and lots of events in MPF. Sometimes they come really fast—a dozen or more in a few milliseconds.
- Not every event will have a handler registered. If something posts an event and nothing is registered to handle it, so be it!
- Multiple handlers can be registered for the same event. In this case the event manager just notifies the handlers one-by-one.
- Event handlers are constantly added and removed throughout the lifecycle of a game. (For example, when a mode starts, all sorts of handlers are registered to watch for things that mode needs, and when the mode ends, those handlers are removed.)
- Event names are *not* case sensitive. (They’re technically all converted to lowercase internally.)

Conditional Events

New in version 0.32.

So far we’ve talked about how events are just strings of text, for example:

- `ball_started`
- `game_ending`
- `shot1_hit`
- `mode_jackpot_starting`
- etc.

However, it’s possible for events to have key/value parameters attached to them.

For example, when the “`ball_started`” event is posted, it has two parameters attached to it: “`ball`” (which is the number of the ball that’s started), and “`player`” which is the number of the player whose ball just started.

This means that the “`ball_started`” event isn’t just MPF saying, “Hey, a ball just started”, rather, it’s more like MPF saying, “Hey, a ball just started for player 2, ball 3.”

By the way, in case you’re wondering how we know that the *ball_started* event has those parameters (or even that *ball_started* is an event), they’re all in the [event reference guide](#), and the entry for *ball_started* lists the parameters it has along with an explanation of what those mean.

Using keyword arguments in your config files

What’s *really cool* about event parameters is that you can use them in your config files when you enter things that take action on events.

For example, here’s a section of a config file that would show a slide called “`lets_go`” when the *ball_started* event was posted:

```
slide_player:
    ball_started: lets_go
```

The example above will show that slide any time that the *ball_started* event was posted, regardless of what the values of the parameters are.

However, you can enter the event name in your config file a bit differently so that the action only takes place if that event is posted AND if the parameters have certain values.

For example:

```
slide_player:
    ball_started{ball==1}: first_ball_intro
```

In the above example, the slide “`first_ball_intro`” will only be posted when the *ball_started* AND when the value of `ball` is 1. (Since this entry doesn’t mention “`player`”, then this action would happen when ball 1 is started for any player.)

Of course you can use multiple entries with different values, like this:


```
slide_player:
  ball_started{ball==1}: first_ball_intro
  ball_started{ball>1}: lets_go
```

In this case, when the *ball_started* event is posted for Ball 1, the “first_ball_intro” slide will be shown. And if it’s posted with a ball after Ball 1, the “lets_go” slide will be posted.

You can also combine things here using and or or. For example:

```
slide_player:
  ball_started{ball==1 or ball==3}: special_slide
```

Now the “special_slide” will be shown for either ball 1 or ball 3.

You can also combine with “and”, for example:

```
slide_player:
  ball_started{ball==3 and player==1}: special_slide
```

Now the “special_slide” will only show when the *ball_started* event is posted for player 1, ball 3 (but not player 2, ball 3, etc.).

Feeling crazy yet?

In addition to keyword arguments from events), you can also use *current_player*. to access player variables, *players[x]* to access player variables from any player (x is the player index), *machine*. to access machine variables, *game*. game attributes, and settings. to access operator settings.

```
slide_player:
  ball_started{current_player.score > 1000000}: you_rule
  ball_started{current_player.score < 10000 and ball == 3}: you_stink
```

The above config will show the slide “you_rule” any time the *ball_started* event is posted and the player’s score is more than 1 million. It will also show the slide “you_stink” if ball 3 is starting and the player has less than 10,000 points.

But wait, there’s more!

You can also use standard math operators (+, -, *, /, etc.) to evaluate whether the action should take place:

```
slide_player:
  ball_started{ball > 1 and current_player.score < ((ball - 1) * 10000)}: uh_oh
```

This will post the slide “uh_oh” if the player is starting a ball after Ball 1 and their score is less than an average of 10k points per ball. (Notice that you can also use parentheses to control the order of operation stuff you learned in school.)

Most likely you wouldn’t get that complex, but it’s nice to know that you can if you want. :)

Things you can use

- *current_player*.
- *players*.
- *game*.

- machine.
- settings.
- device.
- mode.

Comparisons

- == equal
- != not equal
- > greater than
- >= greater than or equal to
- < less than
- <= less than or equal to

Operators

- + add
- - subtract (or negative if there's no space after it)
- * multiply
- / divide
- ^ power (exponent)
- % modulus
- ^= bit xor
- not
- and
- or

Multiple things from one event

Handler Priorities

When you have some code you want to register to be a handler for an event, you can optionally specify a priority. (Priority is just an integer value.) The default priority for events is 1. If you want a guarantee that a certain event handler will fire last, then register that handler with a priority that's lower than any other handler for that event. And if you want to guarantee that a handler fires first, register it with a higher priority. (In this case, "higher" and "lower" are literal. A handler with a priority of 500 will be called before a handler of 100.)

The actual integer values of the priorities are arbitrary. They're called one-by-one, one after the other, in order from highest to lowest. Whether your priorities are 3, 2, and 1, or 1000, 100 and 0, or 1000, 999, 998, and 1 makes no difference.

MPF automatically registers event handlers from modes with the priority of that mode, meaning high-priority modes get access to an event before lower-priority modes. (This is useful since it gives higher-priority modes a chance to “block” events from lower-priority modes.)

Types of events

There are several different *types* of events in MPF, including:

- Basic
- Queue

You can find the details of how to use each of these events by reading through the API documentation for the event manager, but here's a quick overview.

Basic Events

The basic event is a simple event with a name (and possibly keyword argument pairs) that is posted.

The event manager will call the registered handlers one-by-one in the order of their priority (from when they registered).

Queue Events

Queue events are similar to basic events, except that the event won't actually finish until all the handlers say it's ok to do so.

The *game_ending* event is an example of a queue event. When the game is over, *game_ending* is posted, and when that's done, *game_ended* is posted and the attract mode starts again. However there are several modes that might want to “block” the completion of *game_ending* until they can do whatever they need to do. For example, if *match* is enabled, it will want to block *game_ending* until it can run the match animation. If a player has achieved a high score, the high score mode will want to block *game_ending*, etc.

You can create your own queue events with the *queue_event_player:* and *queue_relay_player:* config file sections.

Note for Programmers

If you're a programmer and familiar with Python, you'll notice in the source code that there are more types of events than just basic and queue events. The basic and queue events are the only ones that are exposed via config files, but you'll notice there are boolean and relay events, and that there are asynchronous versions of all events too. See the API reference for details.

Event Reference

Here's a list of all the "built in" events that are included in MPF and the MPF MC. Of course your own machine could include custom events that aren't on the list here.

Every event in MPF is just a string of text. You'll see that in many cases, the actual event that's posted has a slight variation of the event text, typically incorporating something about which mechanism or logic device posted the event.

For example, the event called *switch_(name)_active* will replace the "(name)" part of the event text with the actual switch name. So the when a switch called *s_left_slingshot* is activated, it will posted an event called *switch_s_left_slingshot_active*.

achievement_(name)_state_(state)

MPF Event

Achievement (name) changed to state (state).

Valid states are: disabled, enabled, started, completed

This is only posted once per state. Its also posted on restart on the next ball to restore state.

Keyword arguments

(See the *Conditional Events* guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

restore true if this is reposted to restore state

asset_loading_complete

MPF Event

Posted when the asset manager has loaded all the assets in its queue.

Note that this event does *NOT* necessarily mean that all asset loading is complete. Rather is just means that the asset manager has loaded everything in its queue.

For example, when the MPF-MC boots, it will load the assets it is configured to load on start. However, if the MPF MC is started but MPF is not, then the MPF MC will load its assets and then post this *asset_loading_complete* event when it's done. Then when MPF is started and connects, MPF will need to load its own assets, which means the MPF MC will post more *loading_assets* and then a final *asset_loading_complete* event a second time for the MPF-based assets.

This event does not have any keyword arguments

award_extra_ball

MPF Event

This is an event you can post which will immediately award the player an extra ball (assuming they're within the limits of max extra balls, etc.). This event will in turn post the *extra_ball_awarded* event if the extra ball is able to be awarded.

Note that if you want to just light the extra ball, but not award it right away, then use the [award_lit_extra_ball](#) event instead.

Also note that if an extra ball is lit, this event will NOT unlight or decrement the lit extra ball count. If you want to do that, use the [award_lit_extra_ball](#) instead.

This event does not have any keyword arguments

award_lit_extra_ball

MPF Event

This event will award an extra ball if extra ball is lit. If the player has no lit extra balls, then this event will have no effect.

This is a good event to use in your extra ball mode or shot to post to collect the lit extra ball. It will in turn post the [extra_ball_awarded](#) event (assuming the player has not exceeded any configured limits for max extra balls).

If you just want to award an extra ball regardless of whether the player has one lit, use the [award_extra_ball](#) event instead.

This event does not have any keyword arguments

ball_drain

MPF Event

A ball (or balls) has just drained. (More specifically, ball(s) have entered a ball device tagged with “drain”.)

This is a relay event.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

balls The number of balls that have just drained. Any balls remaining after the relay will be processed as newly-drained balls.

device The ball device object that received the ball(s)

ball_ended

MPF Event

The ball has ended.

Note that this does not necessarily mean that the next player’s turn will start, as this player may have an extra ball which means they’ll shoot again.

This event does not have any keyword arguments

ball_ending

MPF Event

The ball is ending. This is a queue event and the ball won't actually end until the queue is cleared.

This event is posted just after *ball_will_end*

This event does not have any keyword arguments

ball_hold_(name)_balls_released

MPF Event

The ball hold device (name) has just released a ball(s).

Keyword arguments

(See the *Conditional Events* guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

balls_released The number of balls that were just released.

ball_hold_(name)_full

MPF Event

The ball hold device (name) is now full.

Keyword arguments

(See the *Conditional Events* guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

balls The number of balls currently held in this device.

ball_hold_(name)_held_ball

MPF Event

The ball hold device (name) has just held additional ball(s).

Keyword arguments

(See the *Conditional Events* guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

balls_held The number of new balls just held.

total_balls_held The current total number of balls this device has held.

ball_lock_(name)_balls_released

MPF Event

The ball lock device (name) has just released a ball(s).

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

balls_released The number of balls that were just released.

ball_lock_(name)_full

MPF Event

The ball lock device (name) is now full.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

balls The number of balls currently locked in this device.

ball_lock_(name)_locked_ball

MPF Event

The ball lock device (name) has just locked additional ball(s).

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

balls_locked The number of new balls just locked.

total_balls_locked The current total number of balls this device has locked.

ball_save_(name)_disabled

MPF Event

The ball save called (name) has just been disabled.

This event does not have any keyword arguments

ball_save_(name)_enabled

MPF Event

The ball save called (name) has just been enabled.

This event does not have any keyword arguments

ball_save_(name)_grace_period

MPF Event

The ball save called (name) has just entered its grace period time.

This event does not have any keyword arguments

ball_save_(name)_hurry_up

MPF Event

The ball save called (name) has just entered its hurry up mode.

This event does not have any keyword arguments

ball_save_(name)_saving_ball

MPF Event

The ball save called (name) has just saved one (or more) balls.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

balls The number of balls this ball saver is saving.

early_save True if this is an early ball save.

ball_save_(name)_timer_start

MPF Event

The ball save called (name) has just start its countdown timer.

This event does not have any keyword arguments

ball_search_failed

MPF Event

The ball search process has failed to locate a missing or stuck ball and has given up. This event will be posted immediately after the *ball_search_stopped* event.

This event does not have any keyword arguments

ball_search_started

MPF Event

The ball search process has been begun.

This event does not have any keyword arguments

ball_search_stopped

MPF Event

The ball search process has been disabled. This event is posted any time ball search stops, regardless of whether it found a ball or gave up. (If the ball search failed to find the ball, it will also post the *ball_search_failed* event.)

This event does not have any keyword arguments

ball_started

MPF Event

A new ball has started.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

ball The ball number.

player The player number.

ball_starting

MPF Event

A ball is starting. This is a queue event, so the ball won't actually start until the queue is cleared.

This event does not have any keyword arguments

ball_will_end

MPF Event

The ball is about to end. This event is posted just before *ball_ending*.

This event does not have any keyword arguments

balldevice_ball_missing

MPF Event

A ball is missing from a device.

Keyword arguments

(See the *Conditional Events* guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

balls The number of balls that are missing

balldevice_balls_available

MPF Event

A device has balls available to be ejected.

This event does not have any keyword arguments

balldevice_(balls)_ball_missing.

MPF Event

The number of (balls) is missing. Note this event is posted in addition to the generic *balldevice_ball_missing* event.

This event does not have any keyword arguments

balldevice_captured_from_(device)

MPF Event

A ball device has just captured a ball from the device called (device)

Keyword arguments

(See the *Conditional Events* guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

balls The number of balls that were captured.

balldevice_(name)_ball_eject_attempt

MPF Event

The ball device called “name” is attempting to eject a ball (or balls). This is a queue event. The eject will not actually be attempted until the queue is cleared.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

balls The number of balls that are to be ejected.

mechanical_eject Boolean as to whether this is a mechanical eject.

num_attempts How many eject attempts have been tried so far.

source The source device that will be ejecting the balls.

taget The target ball device that will receive these balls.

balldevice_(name)_ball_eject_failed

MPF Event

A ball (or balls) has failed to eject from the device (name).

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

balls The number of balls that failed to eject.

num_attempts How many attempts have been made to eject this ball (or balls).

retry Boolean as to whether this eject will be retried.

target The target device that was supposed to receive the ejected balls.

balldevice_(name)_ball_eject_success

MPF Event

One or more balls has successfully ejected from the device (name).

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

balls The number of balls that have successfully ejected.

target The target device that has received (or will be receiving) the ejected ball(s).

balldevice_(name)_ball_enter

MPF Event

A ball (or balls) have just entered the ball device called “name”.

Note that this is a relay event based on the “unclaimed_balls” arg. Any unclaimed balls in the relay will be processed as new balls entering this device.

Please be aware that we did not add those balls to balls or available_balls of the device during this event.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

device A reference to the ball device object that is posting this event.

unclaimed_balls The number of balls that have not yet been claimed.

balldevice_(name)_ejecting_ball

MPF Event

The ball device called “name” is ejecting a ball right now.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

balls The number of balls that are to be ejected.

mechanical_eject Boolean as to whether this is a mechanical eject.

num_attempts How many eject attempts have been tried so far.

source The source device that will be ejecting the balls.

taget The target ball device that will receive these balls.

balls_in_play

MPF Event

The number of balls in play has just changed, and there is at least 1 ball in play.

Note that the number of balls in play is not necessarily the same as the number of balls loose on the playfield. For example, if the player shoots a lock and is watching a cut scene, there is still one ball in play even though there are no balls on the playfield.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

balls The number of ball(s) in play.

bonus_multiplier

MPF Event

Posted after “bonus_subtotal” and used to trigger the bonus multiplier screen. If the bonus multiplier is 1, then this event is skipped.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

multiplier The numeric value of the bonus multiplier.

bonus_start

MPF Event

The end-of-ball bonus is starting. You can use this event in your slide player to trigger the bonus intro slide. If the game has tilted, this event will not be posted.

This event does not have any keyword arguments

bonus_subtotal

MPF Event

Posted by the bonus mode after all the individual bonus entries have been posted and processed.

This event is typically posted just before the bonus multiplier screen, so if the bonus multiplier is 1, then this event will be skipped.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

score The score of the bonus (so far)

cancel_ball_search

MPF Event

This event will cancel all running ball searches and mark the balls as lost. This is only a handler so all you have to do is to post the event.

This event does not have any keyword arguments

clear

MPF Event

Posted to cause config players to clear whatever they're running based on the key passed. Typically posted when a show or mode ends.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

key string name of the configs to clear

client_connected

MPF Event

Posted on the MPF-MC only when a BCP client has connected.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

address The IP address of the client that connected.

port The port the client connected on.

client_disconnected

MPF Event

Posted on the MPF-MC only (e.g. not in MPF) when the BCP client disconnects. This event is also posted when the MPF-MC starts before a client is connected.

This is useful for triggering a slide notifying of the disconnect.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

host The hostname or IP address that the socket is listening on.

port The port that the socket is listening on.

collecting_balls

MPF Event

Posted by the ball controller when it starts the collecting balls process.

This event does not have any keyword arguments

collecting_balls_complete

MPF Event

Posted by the ball controller when it has finished the collecting balls process.

This event does not have any keyword arguments

(combo_switch)_(state)

MPF Event

Combo switch (name) changed to state (state).

Note that these events can be overridden in a combo switch's config.

Valid states are: *inactive*, *both*, or *one*.

`..rubric:: both`

A switch from group 1 and group 2 are both active at the same time, having been pressed within the `max_offset_time:` and being active for at least the `hold_time:`.

`..rubric:: one`

Either switch 1 or switch 2 has been released for at least the `release_time:` but the other switch is still active.

`..rubric:: inactive`

Both switches are inactive.

This event does not have any keyword arguments

credits_added

MPF Event

Credits (or partial credits) have just been added to the machine.

This event does not have any keyword arguments

display_(name)_initialized

MPF Event

The display called (name) has been initialized. This event is generated in the MC, so it won't be sent to MPF if the MC is started up and ready first.

This event is part of the MPF-MC boot process and is not particularly useful for game developers. If you want to show a “boot” slide as early as possible, use the *mc_ready* event.

This event does not have any keyword arguments

display_(name)_ready

MPF Event

The display target called (name) is now ready and available to show slides.

This event is useful with *slide_frame* widgets where you want to add a *slide_frame* to an existing slide which shows some content, but you need to make sure the *slide_frame* exists before showing a slide.

So if you have a *slide_frame* called “overlay”, then you can add it to a slide however you want, and when it’s added, the event “display_overlay_ready” will be posted, and then you can use that event in your *slide_player* to trigger the first slide you want to show.

Note that this event is posted by MPF-MC and will not exist on the MPF side. So you can use this event for *slide_player*, *widget_player*, etc., but not to start shows or other things controlled by MPF.

This event does not have any keyword arguments

displays_initialized

MPF Event

Posted as soon as MPF MC displays have been initialized.

Note that this event is used as part of the internal MPF-MC startup process. In some cases it will be posted *before* the *slide_player* is ready, meaning that you *CANNOT* use this event to post slides or play sounds.

Instead, use the *mc_ready* event, which is posted as early as possible once the slide player and sound players are setup.

Note that this event is generated by the media controller and does not exist on the MPF side of things.

Also note that if you’re using a media controller other than the MPF-MC (such as the Unity 3D backbox controller), then this event won’t exist.

This event does not have any keyword arguments

diverter_(name)_activating

MPF Event

The diverter called (name) is activating itself, which means it’s physically pulsing or holding the coil to move.

This event does not have any keyword arguments

diverter_(name)_deactivating

MPF Event

The diverter called (name) is deactivating itself.

This event does not have any keyword arguments

diverter_(name)_disabling

MPF Event

The diverter called (name) is disabling itself. Note that if this diverter has `activation_switches:` configured, it will not physically deactivate now, instead deactivating based on switch hits and timing. Otherwise this diverter will deactivate immediately.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

auto Boolean which indicates whether this diverter disabled itself automatically for the purpose of routing balls to their proper location(s).

diverter_(name)_enabling

MPF Event

The diverter called (name) is enabling itself. Note that if this diverter has `activation_switches:` configured, it will not physically activate until one of those switches is hit. Otherwise this diverter will activate immediately.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

auto Boolean which indicates whether this diverter enabled itself automatically for the purpose of routing balls to their proper location(s).

drop_target_bank_(name)_down

MPF Event

Every drop target in the drop target bank called (name) is now in the “down” state. This event is only posted once, when all the drop targets are down.

This event does not have any keyword arguments

drop_target_bank_(name)_mixed

MPF Event

The drop targets in the drop target bank (name) are in a “mixed” state, meaning that they’re not all down or not all up. This event is posted every time a member drop target changes but the overall bank is not not complete.

This event does not have any keyword arguments

drop_target_bank_(name)_up

MPF Event

Every drop target in the drop target bank called (name) is now in the “up” state. This event is only posted once, when all the drop targets are up.

This event does not have any keyword arguments

drop_target_(name)_down

MPF Event

The drop target with the (name) has just changed to the “down” state.

This event does not have any keyword arguments

drop_target_(name)_up

MPF Event

The drop target (name) has just changed to the “up” state.

This event does not have any keyword arguments

enabling_credit_play

MPF Event

The game is no longer on free play. Credits are required to start a game. This event is also posted on MPF boot if the credits mode is enabled and the game is not set to free play.

This event does not have any keyword arguments

enabling_free_play

MPF Event

Credits are no longer required to start a game. This event is also posted on MPF boot if the credits mode is enabled and the game is set to free play.

This event does not have any keyword arguments

extra_ball_awarded

MPF Event

An extra ball was just awarded. This is a good event to use to trigger award shows, sounds, etc.

This event does not have any keyword arguments

extra_ball_disabled_award

MPF Event

Posted when you have the global extra ball settings set to not enable extra balls but where an extra ball would have been awarded. This is a good alternative event to use to score points or whatever else you want to give the player when extra balls are disabled.

This event does not have any keyword arguments

extra_ball_lit

MPF Event

An extra ball was just lit. This is a good event to use to start your extra ball lit mode, or to turn on an extra ball light, etc.

Note that this event is posted if an extra ball is lit during play and also when a player's turn starts if they have a lit extra ball.

See also the [extra_ball_lit_awarded](#) for a similar event that is only posted when an extra ball is lit during play, and not if the player starts their turn with the extra ball lit.

This event does not have any keyword arguments

extra_ball_lit_awarded

MPF Event

This even is posted when an extra ball is lit during play. It is NOT posted when a player's turn starts if they have a lit extra ball from their previous turn. Therefore this event is a good event to use for your award slides and shows when a player lights the extra ball, because you don't want to use [extra_ball_lit](#) because that is also posted when the player's turn starts and you don't want the award show to play again when they're starting their turn.

This event does not have any keyword arguments

extra_ball_lit_max_exceeded

MPF Event

Posted when an extra ball would be lit, except there's a global configured max lit setting and the number of lit extra balls is higher than that.

This event does not have any keyword arguments

extra_ball_max_exceeded

MPF Event

The global configured max extra balls (either for this ball or total for the game for this player has been exceeded, so this event is posted instead of the extra_ball_awarded event.

This event does not have any keyword arguments

extra_ball_unlit

MPF Event

No more lit extra balls are available. This is a good event to use as a stop event for your extra ball lit mode or whatever you're using to indicate to the player that an extra ball is available.

This event does not have any keyword arguments

flipper_cancel

MPF Event

Posted when both flipper buttons are hit at the same time, useful as a “cancel” event for shows, the bonus mode, etc.

Note that in order for this event to work, you have to add left_flipper as a tag to the switch for your left flipper, and right_flipper to your right flipper.

See [combo_switches](#): for details.

This event does not have any keyword arguments

flipper_cradle

MPF Event

Posted when one of the flipper buttons has been active for 3 seconds.

Note that in order for this event to work, you have to add left_flipper as a tag to the switch for your left flipper, and right_flipper to your right flipper.

See [timed_switches](#): for details.

This event does not have any keyword arguments

flipper_cradle_release

MPF Event

Posted when one of the flipper buttons that has previously been active for more than 3 seconds has been released.

If the player pushes in one flipper button for more than 3 seconds, and then the second one and holds it in for more than 3 seconds, this event won't be posted until both buttons have been released.

Note that in order for this event to work, you have to add `left_flipper` as a tag to the switch for your left flipper, and `right_flipper` to your right flipper.

See [timed_switches](#): for details.

This event does not have any keyword arguments

game_ended

MPF Event

The game has ended.

This event does not have any keyword arguments

game_ending

MPF Event

The game is in the process of ending. This is a queue event, and the game won't actually end until the queue is cleared.

This event does not have any keyword arguments

game_start

MPF Event

A game is starting. (Do not use this event to start a game. Instead, use the `request_to_start_game` event.)

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

buttons A list of switches tagged with `player` that were held in when the start button was released. This is used for "alternate" game starts (e.g. hold the right flipper and press start for tournament mode, etc.)

hold_time The time, in seconds, that the start button was held in to start the game. This can be used to start alternate games via a "long press" of the start button.

game_started

MPF Event

A new game has started.

This event does not have any keyword arguments

game_starting

MPF Event

A game is in the process of starting. This is a queue event, and the game won't actually start until the queue is cleared.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

game A reference to the game mode object.

init_done

MPF Event

Posted when the initial (one-time / boot) init phase is done. In other words, once this is posted, MPF is booted and ready to go.

This event does not have any keyword arguments

init_phase_1

MPF Event

Posted during the initial boot up of MPF.

This event does not have any keyword arguments

init_phase_2

MPF Event

Posted during the initial boot up of MPF.

This event does not have any keyword arguments

init_phase_3

MPF Event

Posted during the initial boot up of MPF.

This event does not have any keyword arguments

init_phase_4

MPF Event

Posted during the initial boot up of MPF.

This event does not have any keyword arguments

init_phase_5

MPF Event

Posted during the initial boot up of MPF.

This event does not have any keyword arguments

kickback_(name)_fired

MPF Event

Kickback fired a ball.

This event does not have any keyword arguments

loading_assets

MPF Event

Posted when the number of assets waiting to be loaded changes.

Note that once all the assets are loaded, all the values below are reset to zero.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

loaded The number of assets that have been loaded so far.

percent The numerical percent completion of the assets loaded, express in the range of 0 to 100.

remaining The number of assets that are remaining to be loaded.

total The total number of assets that need to be loaded. This is equal to the sum of the *loaded* and *remaining* values below. It also includes assets that MPF is loading itself as well as any assets that have been reported from remotely connected BCP hosts (e.g. the media controller).

logicblock_(name)_complete

MPF Event

The logic block called “name” has just been completed.

Note that this is the default completion event for logic blocks, but this can be changed in a logic block’s “events_when_complete:” setting, so this might not be the actual event that’s posted for all logic blocks in your machine.

This event does not have any keyword arguments

logicblock_(name)_hit

MPF Event

The logic block “name” was just hit.

Note that this is the default hit event for logic blocks, but this can be changed in a logic block’s “events_when_hit:” setting, so this might not be the actual event that’s posted for all logic blocks in your machine.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

logicblock_(name)_updated

MPF Event

The logic block called “name” has just been completed.

Note that this is the default completion event for logic blocks, but this can be changed in a logic block’s “events_when_complete:” setting, so this might not be the actual event that’s posted for all logic blocks in your machine.

This event does not have any keyword arguments

machine_reset_phase_1

MPF Event

The first phase of resetting the machine.

These events are posted when MPF boots (after the init_phase events are posted), and they’re also posted subsequently when the machine is reset (after existing the service mode, for example).

This is a queue event. The machine reset phase 1 will not be complete until the queue is cleared.

This event does not have any keyword arguments

machine_reset_phase_2

MPF Event

The second phase of resetting the machine.

These events are posted when MPF boots (after the init_phase events are posted), and they’re also posted subsequently when the machine is reset (after existing the service mode, for example).

This is a queue event. The machine reset phase 2 will not be complete until the queue is cleared.

This event does not have any keyword arguments

machine_reset_phase_3

MPF Event

The third phase of resetting the machine.

These events are posted when MPF boots (after the `init_phase` events are posted), and they're also posted subsequently when the machine is reset (after exiting the service mode, for example).

This is a queue event. The machine reset phase 3 will not be complete until the queue is cleared.

This event does not have any keyword arguments

machine_var_(name)

MPF Event

Posted when a machine variable is added or changes value. (Machine variables are like player variables, except they're maintained machine-wide instead of per-player or per-game.)

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

change If the machine variable just changed, this will be the amount of the change. If it's not possible to determine a numeric change (for example, if this machine variable is a list), then this *change* value will be set to the boolean *True*.

prev_value The previous value of this machine variable, e.g. what it was before the current value.

value The new value of this machine variable.

magnet_(name)_flinged_ball

MPF Event

The magnet called (name) has just flinged a ball.

This event does not have any keyword arguments

magnet_(name)_flinging_ball

MPF Event

The magnet called (name) is flinging a ball by disabling and enabling the magnet again for a short time.

This event does not have any keyword arguments

magnet_(name)_grabbed_ball

MPF Event

The magnet called (name) has completed grabbing the ball. Note that the magnet doesn't actually "know" whether it successfully grabbed a ball or not, so this even is saying that it things it did. to).

This event does not have any keyword arguments

magnet_(name)_grabbing_ball

MPF Event

The magnet called (name) is attempting to grab a ball.

This event does not have any keyword arguments

magnet_(name)_released_ball

MPF Event

The magnet called (name) has just released a ball.

This event does not have any keyword arguments

magnet_(name)_releasing_ball

MPF Event

The magnet called (name) is in the process of releasing a ball.

This event does not have any keyword arguments

master_volume_decrease

MPF Event

Decrease the master volume of the audio system.

This event does not have any keyword arguments

master_volume_increase

MPF Event

Increase the master volume of the audio system.

This event does not have any keyword arguments

max_credits_reached

MPF Event

Credits have just been added to the machine, but the configured maximum number of credits has been reached.

This event does not have any keyword arguments

mc_ready

MPF Event

Posted when the MPF-MC is available to start showing slides and playing sounds.

Note that this event does not mean the MC is done loading. Instead it's posted at the earliest possible moment that the core MC components are available, meaning you can trigger "boot" slides from this event (which could in turn be used to show asset loading status, boot progress, etc.)

If you want to show slides that require images or video loaded from disk, use the event "init_done" instead which is posted once all the assets set to "preload" have been loaded.

This event does not have any keyword arguments

mc_reset_complete

MPF Event

Posted on the MPF-MC only (e.g. not in MPF). This event is posted when the MPF-MC reset process is complete.

This event does not have any keyword arguments

mc_reset_phase_1

MPF Event

Posted on the MPF-MC only (e.g. not in MPF). This event is used internally as part of the MPF-MC reset process.

This event does not have any keyword arguments

mc_reset_phase_2

MPF Event

Posted on the MPF-MC only (e.g. not in MPF). This event is used internally as part of the MPF-MC reset process.

This event does not have any keyword arguments

mc_reset_phase_3

MPF Event

Posted on the MPF-MC only (e.g. not in MPF). This event is used internally as part of the MPF-MC reset process.

This event does not have any keyword arguments

mode_(name)_started

MPF Event

Posted when a mode has started. The “name” part is replaced with the actual name of the mode, so the actual event posted is something like *mode_attract_started*, *mode_base_started*, etc.

This is posted after the “mode_(name)_starting” event.

This event does not have any keyword arguments

mode_(name)_starting

MPF Event

The mode called “name” is starting.

This is a queue event. The mode will not fully start until the queue is cleared.

This event does not have any keyword arguments

mode_(name)_stopped

MPF Event

Posted when a mode has stopped. The “name” part is replaced with the actual name of the mode, so the actual event posted is something like *mode_attract_stopped*, *mode_base_stopped*, etc.

This event does not have any keyword arguments

mode_(name)_stopping

MPF Event

The mode called “name” is stopping. This is a queue event. The mode won’t actually stop until the queue is cleared.

This event does not have any keyword arguments

motor_(name)_reached_(position)

MPF Event

A motor device called (name) reached position (position) (device)

This event does not have any keyword arguments

multi_player_ball_started

MPF Event

A new ball has started, and this is a multiplayer game.

This event does not have any keyword arguments

multiball_lock_(name)_full

MPF Event

The multiball lock device (name) is now full.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

balls The number of balls currently locked in this device.

multiball_lock_(name)_locked_ball

MPF Event

The multiball lock device (name) has just locked one additional ball.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

total_balls_locked The current total number of balls this device has locked.

multiball_(name)_ended

MPF Event

The multiball called (name) has just ended.

This event does not have any keyword arguments

multiball_(name)_lost_ball

MPF Event

The multiball called (name) has lost a ball after ball save expired.

This event does not have any keyword arguments

multiball_(name)_shoot_again

MPF Event

A ball has drained during the multiball called (name) while the ball save timer for that multiball was running, so a ball (or balls) will be saved and re-added into play.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

balls The number of balls that are being saved.

multiball_(name)_shoot_again_ended

MPF Event

Shoot again for multiball (name) has ended.

This event does not have any keyword arguments

multiball_(name)_started

MPF Event

The multiball called (name) has just started.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

balls The number of balls in this multiball

multiplayer_game

MPF Event

A second player has just been added to this game, meaning this is now a multiplayer game.

This event is typically used to switch the score display from the single player layout to the multiplayer layout.

This event does not have any keyword arguments

not_enough_credits

MPF Event

A player has pushed the start button, but the game is not set to free play and there are not enough credits to start a game or add a player.

This event does not have any keyword arguments

player_add_request

MPF Event

Posted to request that an additional player be added to this game. Any registered handler can deny the player add request by returning *False* to this event.

This event does not have any keyword arguments

player_add_success

MPF Event

A new player was just added to this game

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

num The number of the player that was just added. (e.g. Player 1 will have *num=1*, Player 4 will have *num=4*, etc.)

player A reference to the instance of the `Player()` object.

player_turn_start

MPF Event

A new player's turn will start. This event is only posted before the start of a new player's turn. If that player gets an extra ball and shoots again, this event is not posted a second time.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

number The player number

player The player object whose turn is starting.

player_turn_started

MPF Event

A new player's turn started. This event is only posted after the start of a new player's turn. If that player gets an extra ball and shoots again, this event is not posted a second time.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

number The player number

player The player object whose turn is starting.

player_turn_starting

MPF Event

A new player's turn is starting. This event is only posted at the start of a new player's turn. If that player gets an extra ball and shoots again, this event is not posted a second time.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

number The player number

player The player object whose turn is starting.

player_turn_stop

MPF Event

The player's turn is ending. This event is only posted when this player's turn is totally over. If the player gets an extra ball and shoots again, this event is not posted until after all their extra balls and it's no longer their turn.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

number The player number

player The player object whose turn is over.

player_(var_name)

MPF Event

Posted when simpler types of player variables are added or change value.

The actual event has (var_name) replaced with the name of the player variable that changed. Some examples:

- player_score
- player_shot_upper_lit_hit

Lots of things are stored in player variables, so there's no way to build a complete list of what all the options are here. Elsewhere in the documentation, if you see something that says it's stored in a player variable, that means you'll get this event when that player variable is created or is changed.

Note that this event is only posted for simpler types of player variables, including player variables that are integers, floating point numbers, or strings. More complex player variables (lists, dicts, etc.) do not get this event posted.

This event is posted for a single player variable changing, meaning if multiple player variables change at the same time, multiple events will be posted, one for each change.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

change If the player variable just changed, this will be the amount of the change. If it's not possible to determine a numeric change (for example, if this player variable is a string), then this *change* value will be set to the boolean *True*.

player_num The player number this variable just changed for, starting with 1. (e.g. Player 1 will have *player_num=1*, Player 4 will have *player_num=4*, etc.)

prev_value The previous value of this player variable, e.g. what it was before the current value.

value The new value of this player variable.

(playfield)_active

MPF Event

The playfield called "playfield" is now active, meaning there's at least one loose ball on it.

This event does not have any keyword arguments

(playfield)_ball_count_change

MPF Event

The playfield with the name "playfield" has changed the number of balls that are live.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

balls The current number of balls on the playfield.

change The change in balls from the last count.

playfield_transfer_(playfield_transfer)_ball_transferred

MPF Event

The playfield_transfer called (playfield_transfer) transferred a ball from playfield (source) to playfield (target).

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

source The source playfield.

target The target playfield.

reel_(name)_advance

MPF Event

The score reel (name) is advancing.

This event does not have any keyword arguments

reel_(name)_hw_value

MPF Event

The score reel (name) has checked its hardware switches.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

value The physical confirmed value of the reel. (Will be -999 if the reel is not at a position with a switch.)

reel_(name)_ready

MPF Event

The score reel (name) is ready to be pulsed again.

This event does not have any keyword arguments

reel_(name)_resync

MPF Event

The score reel (name) is not valid and will be resyncing.

This event does not have any keyword arguments

request_to_start_game

MPF Event

This event is posted when to start a game. This is a boolean event. Any handler can return *False* and the game will not be started. Otherwise when this event is done, a new game is started.

Posting this event is the only way to start a game in MPF, since many systems have to “approve” the start. (Are the balls in the right places, are there enough credits, etc.)

This event does not have any keyword arguments

reset_complete

MPF Event

The machine reset process is complete

This event does not have any keyword arguments

scorereelgroup_(name)_resync

MPF Event

The score reel group (name) is not valid and will be resyncing.

This event does not have any keyword arguments

scorereelgroup_(name)_rollover

MPF Event

The score reel group (name) has just rolled over, meaning it exceeded its mechanical limit and rolled over past zero.

This event does not have any keyword arguments

scorereelgroup_(name)_valid

MPF Event

The score reel group (name) is valid.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

value The integer value this score reel group is assumed to be at.

(shot_group)_complete

MPF Event

All the member shots in the shot group called (shot_group) are in the same state.

This event does not have any keyword arguments

(shot_group)_hit

MPF Event

A member shot in the shot group called (shot_group) was just hit.

Note that there are three events posted when a member shot is hit, each with variants of the shot name, profile, and current state, allowing you to key in on the specific granularity you need.

Also remember that shots can have more than one active profile at a time (typically each associated with a mode), so a single hit to this shot might result in this event being posted multiple times with different (profile) values.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

profile The name of the profile that was active when hit.

state The name of the state the profile was in when it was hit

(shot_group)_profile_complete

MPF Event

All the member shots in the shot group called (shot_group) with the profile called (profile) are in the same state.

This event does not have any keyword arguments

(shot_group)_profile_hit

MPF Event

A member shot in the shot group called (shot_group) was just hit with the profile called (profile) applied.

Note that there are three events posted when a member shot is hit, each with variants of the shot name, profile, and current state, allowing you to key in on the specific granularity you need.

Also remember that shots can have more than one active profile at a time (typically each associated with a mode), so a single hit to this shot might result in this event being posted multiple times with different (profile) values.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

profile The name of the profile that was active when hit.

state The name of the state the profile was in when it was hit

(shot_group)_(profile)_(state)_complete

MPF Event

All the member shots in the shot group called (shot_group) with the profile called (profile) are in the same state with the name (state).

This event does not have any keyword arguments

(shot_group)_(profile)_(state)_hit

MPF Event

A member shot in the shot group called (shot_group) was just hit with the profile called (profile) applied in the current state called (state).

Note that there are three events posted when a member shot is hit, each with variants of the shot name, profile, and current state, allowing you to key in on the specific granularity you need.

Also remember that shots can have more than one active profile at a time (typically each associated with a mode), so a single hit to this shot might result in this event being posted multiple times with different (profile) values.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

profile The name of the profile that was active when hit.

state The name of the state the profile was in when it was hit

(shot)_hit

MPF Event

The shot called (shot) was just hit.

Note that there are four events posted when a shot is hit, each with variants of the shot name, profile, and current state, allowing you to key in on the specific granularity you need.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

profile The name of the profile that was active when hit.

state The name of the state the profile was in when it was hit

(shot)_(profile)_hit

MPF Event

The shot called (shot) was just hit with the profile (profile) active.

Note that there are four events posted when a shot is hit, each with variants of the shot name, profile, and current state, allowing you to key in on the specific granularity you need.

Also remember that shots can have more than one active profile at a time (typically each associated with a mode), so a single hit to this shot might result in this event being posted multiple times with different (profile) values.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

profile The name of the profile that was active when hit.

state The name of the state the profile was in when it was hit

(shot)_(profile)_(state)_hit

MPF Event

The shot called (shot) was just hit with the profile (profile) active in the state (state).

Note that there are four events posted when a shot is hit, each with variants of the shot name, profile, and current state, allowing you to key in on the specific granularity you need.

Also remember that shots can have more than one active profile at a time (typically each associated with a mode), so a single hit to this shot might result in this event being posted multiple times with different (profile) and (state) values.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

profile The name of the profile that was active when hit.

state The name of the state the profile was in when it was hit

(shot)_(state)_hit

MPF Event

The shot called (shot) was just hit while in the profile (state).

Note that there are four events posted when a shot is hit, each with variants of the shot name, profile, and current state, allowing you to key in on the specific granularity you need.

Also remember that shots can have more than one active profile at a time (typically each associated with a mode), so a single hit to this shot might result in this event being posted multiple times with different (profile) and (state) values.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

profile The name of the profile that was active when hit.

state The name of the state the profile was in when it was hit

shutdown

MPF Event

Posted when the machine is shutting down to give all modules a chance to shut down gracefully.

This event does not have any keyword arguments

single_player_ball_started

MPF Event

A new ball has started, and this is a single player game.

This event does not have any keyword arguments

slam_tilt

MPF Event

A slam tilt has just occurred.

This event does not have any keyword arguments

slide_(name)_active

MPF Event

A slide called (name) has just become active, meaning that it's now showing as the current slide.

This is useful for things like the widget_player where you want to target a widget for a specific slide, but you can only do so if that slide exists.

Slide names do not take into account what display or slide frame they're playing on, so be sure to create machine-wide unique names when you're naming your slides.

This event does not have any keyword arguments

slide_(name)_created

MPF Event

A slide called (name) has just been created.

This means that this slide now exists, but it's not necessarily the active (showing) slide, depending on the priorities of the other slides and/or what else is going on.

This is useful for things like the `widget_player` where you want to target a widget for a specific slide, but you can only do so if that slide exists.

Slide names do not take into account what display or slide frame they're playing on, so be sure to create machine-wide unique names when you're naming your slides.

This event does not have any keyword arguments

slide_(name)_removed

MPF Event

A slide called (name) has just been removed.

This event is posted whenever a slide is removed, regardless of whether or not that slide was active (showing).

Note that even though this event is called "removed", it's actually posted as part of the removal process. (e.g. there are still some clean-up things that happen afterwards.)

Slide names do not take into account what display or slide frame they're playing on, so be sure to create machine-wide unique names when you're naming your slides.

This event does not have any keyword arguments

sw_(playfield)_active

MPF Event

The playfield called (playfield) was active, though a ball was just removed from it.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

balls The number of balls that were just removed from this playfield.

sw_(tag_name)

MPF Event

A switch tagged with *tag_name* was just activated.

For example, if in the `switches:` section of your config, you have a switch with tags: `start`, `hello`, then the events `sw_start` and `sw_hello` will be posted when that switch is hit.

Note that you can change the format of these events in your machine config file, but `sw_(tag_name)` is the default.

This event does not have any keyword arguments

switch_(name)_active

MPF Event

Posted on MPF-MC only (e.g. not in MPF) when the MC receives a BCP “switch” active command. Useful for video modes and graphical menu navigation. Note that this is not posted for every switch all the time, rather, only for switches that have been configured to send events to BCP.

This event does not have any keyword arguments

switch_(name)_inactive

MPF Event

Posted on MPF-MC only (e.g. not in MPF) when the MC receives a BCP “switch” inactive command. Useful for video modes and graphical menu navigation. Note that this is not posted for every switch all the time, rather, only for switches that have been configured to send events to BCP.

This event does not have any keyword arguments

text_input_(key)_abort

MPF Event

This event is posted by a `text_input` display widget when the entering process was aborted.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

text A string of the characters that were entered so far.

text_input_(key)_complete

MPF Event

This event is posted by a `text_input` display widget when the entered text is finalized.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

text A string of the final characters that were entered.

tilt

MPF Event

The player has tilted.

This event does not have any keyword arguments

tilt_clear

MPF Event

Posted after a tilt, when the settling time has passed after the last tilt switch hit. This is used to hold the next ball start until the plumb bob has settled to prevent tilt throughs.

This event does not have any keyword arguments

tilt_warning

MPF Event

A tilt warning just happened.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

warnings The total number of warnings so far.

warnings_remaining The remaining number of warnings until a tilt.

tilt_warning_(number)

MPF Event

A tilt warning just happened. The number of this tilt warning is in the event name in the (number).

This event does not have any keyword arguments

timer_(name)_complete

MPF Event

The timer named (name) has completed.

Note that this timer may reset and start again after this event is posted, depending on its settings.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

ticks The current tick number this timer is at.

ticks_remaining The number of ticks in this timer remaining.

timer_(name)_paused

MPF Event

The timer named (name) has paused.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

ticks The current tick number this timer is at.

ticks_remaining The number of ticks in this timer remaining.

timer_(name)_started

MPF Event

The timer named (name) has just started.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

ticks The current tick number this timer is at.

ticks_remaining The number of ticks in this timer remaining.

timer_(name)_stopped

MPF Event

The timer named (name) has stopped.

This event is posted any time the timer stops, whether it stops because it ended or because it was stopped early by some other event.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

ticks The current tick number this timer is at.

ticks_remaining The number of ticks in this timer remaining.

timer_(name)_tick

MPF Event

The timer named (name) has just counted down (or up, depending on its settings).

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

ticks The new tick number this timer is at.

ticks_remaining The new number of ticks in this timer remaining.

timer_(name)_time_added

MPF Event

The timer named (name) has just had time added to it.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

ticks The new tick number this timer is at.

ticks_added How many ticks were just added.

ticks_remaining The new number of ticks in this timer remaining.

timer_(name)_time_subtracted

MPF Event

The timer named (name) just had some ticks removed.

Keyword arguments

(See the [Conditional Events](#) guide for details for how to create entries in your config file that only respond to certain combinations of the arguments below.)

ticks The new current tick number this timer is at.

ticks_remaining The new number of ticks in this timer remaining.

ticks_subtracted How many ticks were just subtracted from this timer. (This number will be positive, indicating the ticks subtracted.)

unexpected_ball_on_(playfield)

MPF Event

The playfield named “playfield” just had a switch hit, meaning a ball is on it, but that ball was not expected.

This event does not have any keyword arguments

Player Variables Reference

Here's a list of all the different "built in" *player variables* that MPF uses.

You can use these in your config files to trigger game logic or to display as text on your display.

Note that you can also create your own player variables in your configs, and most likely your machine will have several orders of magnitude more player variables than this list here.

That said, here's a list of the "built in" player variables and how they work:

index

MPF player variable

The index of this player, starting with 0. For example, Player 1 has an index of 0, Player 2 has an index of 1, etc.

If you want to get the player number, use the "number" player variable instead.

ball

MPF player variable

The ball number for this player. If a player gets an extra ball, this number won't change when they start the extra ball.

(logic_block)_count

MPF player variable

The default player variable name that's used to store the count value for a counter player variable. Note that the (logic_block) part of the player variable name is replaced with the actual logic block's name.

Also note that it's possible to override the player variable name that's used by default and to specify your own name. You do this in the `player_variable:` part of the logic block config.

((logic_block)_state)

MPF player variable

A dictionary that stores the internal state of the logic block with the name (logic_block). (In other words, a logic block called `mode1_hit_counter` will store its state in a player variable called `mode1_hit_counter_state`).

The state that's stored in this variable include whether the logic block is enabled and whether it's complete.

The actual value of the logic block is stored in another player variable whose name you can specify via the `player_variable:` setting in the individual logic block config.

((logic_block)_status)

MPF player variable

The default player variable name that's used to store the accrual state for an accrual player variable. Note that the (logic_block) part of the player variable name is replaced with the actual logic block's name.

Also note that it's possible to override the player variable name that's used by default and to specify your own name. You do this in the `player_variable:` part of the logic block config.

((logic_block)_step)

MPF player variable

The default player variable name that's used to store the current step for a sequence player variable. Note that the (logic_block) part of the player variable name is replaced with the actual logic block's name.

Also note that it's possible to override the player variable name that's used by default and to specify your own name. You do this in the `player_variable:` part of the logic block config.

logic_blocks

MPF player variable

A set which contains references to all the logic blocks which exist for this player. There's nothing useful in here for you, we just include it so you know what this player variable does.

((mode)_(timer)_tick

MPF player variable

Stores the current tick value for the timer from the mode (mode) with the time name (timer). For example, a timer called “my_timer” which is in the config for “mode1” will store its tick value in the player variable mode1_my_timer_tick.

number

MPF player variable

The number of the player, beginning with 1. (e.g. Player 1 has a number of “1”, Player 2 is “2”, etc.

random_(x).(y)

MPF player variable

Holds references to Randomizer settings that need to be tracked on a player basis. There is nothing you need to know or do with this, rather this is just FYI on what the player variables that start with “random_” are.

restart_modes_on_next_ball

MPF player variable

A list of modes that will be restarted when this player’s next ball starts. This is more of an internal thing that MPF uses versus something that has a lot of value to you.

(shot)_(profile)

MPF player variable

The profile step (starting with 0) this profile is in for this shot. The actual name of the player variable is the name (shot)_(profile). For example, if you have a shot called “right_ramp” and a profile called “flash”, the current step the profile is at for that shot will be stored in a player variable called right_ramp_flash.

Note that you can override this default player variable name with the “player_variable” setting in a shot profile.

Machine Variables

Machine variables are similar to *player variables*, except that machine variables are machine-wide and persist between games. (In fact, machine variables can be configured to be saved to disk so they also persist between reboots of MPF.)

Like player variables, you can use machine variables in your config files, particularly in text display widgets, to show things on your display.

You can create your own machine variables in your configs. There are also several machine variables that are automatically created. Here's a list of the machine variables that are "built in" and available for use in your configs:

credit_units

MPF machine variable

How many credit units are on the machine. Note that credit units are not useful for display purposes since they represent the number of credits in a ration related to the lowest common denominator of the partial credit fraction. See the related *credits_string* and *credits_value* machine variables for more useful formats.

credits_numerator

MPF machine variable

The numerator portion of the total credits on the machine. For example, if the machine has 4 1/2 credits, this value is "1".

credits_string

MPF machine variable

Holds a displayable string which shows how many credits are on the machine. For example, "CREDITS: 1". If the machine is set to free play, the value of this string will be "FREE PLAY".

You can change the format and value of this string in the `credits:` section of the machine config file.

credits_value

MPF machine variable

The human readable string form which shows the number value of how many credits are on the machine, including whole and fractional credits, for example "1" or "2 1/2" or "3 3/4".

If you want the full string with the word "CREDITS" in it, use the "credits_string" machine variable.

credits_whole_num

MPF machine variable

The denominator portion of the total credits on the machine. For example, if the machine has 4 1/2 credits, this value is "2".

fast_(x)_firmware

MPF machine variable

Holds the version number of the firmware for the processor on the FAST Pinball controller that's connected. The "x" is replaced with either "dmd", "net", or "rgb", one for each processor that's attached.

fast_(x)_model

MPF machine variable

Holds the model number of the board for the processor on the FAST Pinball controller that's connected. The "x" is replaced with either "dmd", "net", or "rgb", one for each processor that's attached.

(high_score_category)(position)_label

MPF machine variable

The "label" of the high score for that specific score category and position. For example, `score1_label` holds the label for the #1 position of the "score" player variable (which might be "GRAND CHAMPION").

((high_score_category)(position)_name

MPF machine variable

Holds the player's name (or initials) for the high score for that category and position.

((high_score_category)(position)_value

MPF machine variable

Holds the numeric value for the high score for that category and position.

mpf_extended_version

MPF machine variable

New in version 0.33.

Holds the version number of MPF and sub-components (ex: "MPF v0.33.0, Config version: 4, Show version: 4, BCP version: 1.1").

mpf_version

MPF machine variable

New in version 0.33.

Holds the version number of MPF (ex: "MPF v0.33.0").

p_roc_revision

MPF machine variable

Holds the revision number of the P-ROC or P3-ROC controller that's attached to MPF.

p_roc_version

MPF machine variable

Holds the version number of the P-ROC or P3-ROC controller that's attached to MPF.

platform

MPF machine variable

New in version 0.33.

Contains a string identifying the underlying platform with as much useful information as possible (ex: "Windows-10-10.0.14393").

platform_machine

MPF machine variable

New in version 0.33.

Contains a string identifying the underlying machine type (ex: "i386").

platform_release

MPF machine variable

New in version 0.33.

Contains a string identifying the underlying system's release (ex: "10").

platform_system

MPF machine variable

New in version 0.33.

Contains a string identifying the system/OS name (ex: "Windows").

platform_version

MPF machine variable

New in version 0.33.

Contains a string identifying the underlying system's release version (ex: "10.0.14393").

player(x)_score

MPF machine variable

Holds the numeric value of a player's score. The "x" is the player number, so this actual machine variable is player1_score or player2_score.

Since these are machine variables, they are maintained even after a game is over. Therefore you can use these machine variables in your attract mode display show to show the scores of the last game that was played.

These machine variables are updated at the end of each player's turn, and they persist on disk so they are restored the next time MPF starts up.

python_version

MPF machine variable

New in version 0.33.

Contains the current Python version as string “major.minor.patchlevel” (ex: “3.4.4”).

Developer Documentation

We talk a lot about how you don't have to be an experienced software developer to use MPF. However, if you are an experienced developer, there are a few ways you can leverage your coding knowledge:

- You can add custom code to your machine for parts of your game where you'd rather write "real" code versus using config files.
- You can add custom code to handle unique and one-off hardware.
- You can write Python-based unit tests to test your machine.
- You can extend MPF to add features or to support new types of hardware.

Instructions for all of this, as well as an API reference, is available at the MPF Developer Documentation website:

<http://developer.missionpinball.org>

About the MPF Documentation

If you'd like to help write or improve this documentation (even if it's a simple typo correction), see the [Contributing to the MPF documentation](#) guide for details.

MPF documentation authors

This MPF documentation was written by:

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Want to help with the docs? See our [Contributing to MPF's Documentation](#) page for details. It's easy!

MPF license & copyright

The Mission Pinball Framework code and all documentation is licensed in a way that basically means you can do whatever you want with it. The only real caveat is that you use it at your own risk, and we don't provide any warranties.

The code is licensed under the [MIT license](#), and the documentation is licensed via [Creative Commons Attribution 4.0 International \(CC BY 4.0\)](#).

It a nutshell, you can use MPF and the docs however you want. You can use MPF in a commercial product. You can make changes to it, and you don't have to share the changes back with the community if you don't want to. You can make derivative works, sell it, build a business on it, etc. Go nuts!

At the end of the day, we created MPF because we want to see more pinball in the world, so we didn't put any restrictions on what you can do with it because we don't want anyone to hesitate jumping into the amazing world of pinball!

FAQ: General

Why does this project exist?

The Mission Pinball Framework was started in 2014 by Brian Madden and Gabe Knuth. Both of them had dreamed of building their own pinball machines for years, and in 2013, they discovered the P-ROC and the wonderful community of home brew pinball builders and hackers.

The P-ROC pinball control system works with an open source project called [pyprocgame](#) which is a Python-based game framework. Pyprocgame is great, but it's pretty basic. (It's more of a pinball development environment versus a complete framework.) One of the challenges we saw was that people kept on having to "reinvent the wheel" with each game they built. After reading forum posts about "How do you write code for a trough?" about ten times, we thought, "Why isn't there a framework that just 'does that' for you?"

Pyprocgame also requires everything to be written in Python code, and we found that a lot of people who wanted to build their own pinball machines weren't software developers. So we thought it would be cool to create a framework where the majority of the "programming" could be done with text-based configuration files.

So in June 2014, we decided to start building the Mission Pinball Framework.

Around the same time, FAST Pinball came onto the market to offer an alternative control system to the P-ROC and P3-ROC. At that we thought, "Great, let's make the Mission Pinball Framework so that's it's hardware-independent and can work with the FAST Pinball or P-ROC systems (plus any other future systems that came out).

Isn't using config files limiting?

Finding the balance between "config files" and "real programming" is an age-old battle. We have a guide called [Config files versus "real" programming](#) which explains this in more detail, including our

perspective on it and why we decided to make config files the focus on MPF.

Can I mix “real” code in with MPF config files?

Yes! See developer.missionpinball.org for details and examples.

Where does the name come from?

Brian lives in San Francisco’s “Mission” neighborhood. There are a lot of “Mission” things here, Mission Bowling, Mission Coffee, Mission Ice Cream. . . So we thought “Mission Pinball” had a great ring to it!

What pinball hardware does MPF work with?

The complete hardware compatibility list is [here](#).

Who’s behind this?

Even though MPF was started by Brian Madden and Gabe Knuth, our team has grown to involve lots of people. See the [AUTHORS](#) file in the MPF package for the latest list.

Is MPF stable?

MPF is open source software that is not yet at a 1.0 release. However we’ve been working on it since 2014, and several complete pinball machines have been built using it.

Furthermore, when we find crashes, we fix them. If you look at the list of commits (code additions, changes, and fixes that we check in) on [GitHub](#), you’ll see that we’re busy with dozens of commits per week!

Is MPF beta? When will v1 be released?

MPF is open source and continuously developed. We’re currently say, “Yes, it’s beta” since we are not yet at a 1.0 release. However we release new versions every few months and don’t expect that to change anytime soon.

We do expect to get to a 1.0 release at some point, but we don’t have a specific time-frame for that. The important thing is to look at the [code commit history](#) and to notice that MPF is being very actively developed!

How can I download the documentation and read it offline?

Click the “Read the Docs” link in the lower-left corner of any page of the MPF documentation on docs.missionpinball.org for links to PDF, HTML, and Epub versions of the documentation.

What other options are there besides MPF?

While we think MPF is awesome, our main goal is to see more pinball in the world! Since all of us are working on MPF in our spare time (and not being paid for it), we won't be offended if you don't use MPF. Just please create more pinball!

At this time, if you don't want to use MPF, there are a few other options:

- [pyprocgame](#) (P-ROC/P3-ROC only)
- [PyProcGameHD+SkeletonGame](#) (P-ROC/P3-ROC only, adds HD graphics and more to pyprocgame)
- [Open Pinball Project framework](#) (Open Pinball Project hardware only)
- [Rampant Slug Framework](#) (P-ROC/P3-ROC only)
- [FreeWPC](#) (WPC hardware only, lets you write new code in C, burn it to ROMS, and run it on original WPC hardware)

FAQ: Installation

How do I get started?

Start with the [Start Here](#) link in the menu on the left. That will explain an overview of how MPF works and then lead you through the features, the tutorial, and so on.

What are the prerequisites?

If you just want to start playing with MPF, you do not need a physical pinball machine. In fact we have a graphical tool (the [MPF Monitor](#)) which simulates a real pinball machine, so you can probably build an entire game without having an actual pinball machine.

If you want to use a real pinball machine (or build a real machine), you need to pick a pinball control system. (We have a list of supported control systems [here](#).) If you want to get started as cheaply as possible, the Open Pinball Project hardware is open source which you can build yourself. You can probably build all the hardware you need for under \$100.

What computer hardware do I need?

MPF supports Windows, Mac, and Linux, so pretty much any computer is fine. Most people do their development of MPF on whatever computer they use in their daily lives, then when they're getting close to done with their machine, they install a dedicated computer (or even a Raspberry Pi) in their machine to run MPF.

What Python version can I use with MPF?

On Windows, you need Python 3.4. Mac and Linux can use Python 3.4 or 3.5. Python 3.6 and newer are not supported. We walk you through getting Python installed in our [installation documentation](#).

Should I use the stable version or development version?

We recommend that people use the latest “stable” (or “release”) version of MPF unless you need specific features from the “dev” (next) version.

The current “stable” version of MPF is listed on the top of the [MPF Users home page on Google Groups](#).

Where do I find information on older versions of MPF?

If you want information about an older version (0.30 and newer), click the “Read the Docs” link in the lower-left corner of any page on docs.missionpinball.org and select the version you want to read about.

You can install older versions of MPF with pip, like this:

```
pip install mpf-mc==0.31
```

Documentation for versions of MPF prior to 0.30 is available in [this post](#)

FAQ: Building your game

Where do I get help building my machine?

If you’re looking for information about physically building your machine, check out the [PinballMakers.com](https://www.pinballmakers.com) website.

I want to do something that’s not in MPF. Now what?

Awesome!

First, you can check out the list of new features that we’re tracking.

- [MPF New Features](#)
- [MPF-MC New Features](#)
- [MPF Monitor New Features](#)

If you see your feature there, you can click on it and then click the “Subscribe” button to receive email notifications of progress or when it’s been added.

You can also read our [MPF Road Map, Vision & Future](#) for an idea of our longer-term plans for MPF.

If you still don’t see your idea, or you’d like to talk about it or ask questions, feel free to post a message to the [MPF Users Google Group](https://groups.google.com/forum/#!forum/mpf-users) <<https://groups.google.com/forum/#!forum/mpf-users>>.

FAQ: Getting help

Where can I go for help?

If you’re stuck with something, feel free to post a message to the [MPF Users Google Group](#).

I think I've found a bug. Now what?

Again, post it to the [MPF Users Google Group](#).

I want MPF to work with a new piece of hardware

Awesome! We've designed MPF to be platform-independent, meaning that the core MPF software doesn't talk to hardware directly. Instead we have "platform interfaces" for different types of hardware.

The easiest way to understand how these work is to look through the code for the existing platform interfaces. This code is in the [platforms folder in MPF](#).

As always, if you have questions, please post them to the [MPF Users Google Group](#) and we'll go from there!

Glossary of MPF terms

Here's a list of terms you might come across in MPF. Note that this is not an exhaustive list of everything, rather, these are terms we use in MPF that might not be obvious.

display A logical target which holds slides. Displays are abstract—purely logical. You use the machine config to map logical displays to the physical on-screen window or a DMD.

machine folder The folder which holds your machine config files.

player variable A named value that is stored on a per-player basis, such as the current ball number or score.

watch dog A feature of a hardware control system that ensures you don't blow anything up if MPF crashes. Essentially it's a timer which runs on the hardware (typically set to a short amount of time, like 1 second) that has to be "pinged" by MPF constantly to reset the timer. If the timer runs out before its pinged, then the hardware system will shut off all power to its devices. In normal operation, MPF pings the watchdog constantly, but if MPF crashes or shuts down ungracefully, then the watchdog pings stop, the hardware timer expires, and the hardware controller shuts off all the power to the connected devices.

widget A thing that is put on a display. There are different types of widgets, such as text, images, videos, shapes, etc.

Contributing to MPF

Want to add a feature? A missing event somewhere? Wrote a new device which might be useful for other users? Fixed a bug? Added some small missing piece?

We'd love to take your contribution upstream!

Found a bug which you can reproduce? Fill an issue:

- [MPF Issues on github](#). Use this for game and platform related bugs
- [MPF-MC Issues on github](#). Use this for media controller bugs such as problems with slides, widgets or audio.

If you want to discuss a feature or bug (or if you are unsure). Visit our forum:

<https://groups.google.com/forum/#!forum/mpf-users>

Install MPF in development mode

To work on MPF you need to install it in developer/editable mode:

1. Fork the [mpf repo](#) on GitHub.
2. Fork the [mpf-mc repo](#) on GitHub (only needed for media controller changes - skip otherwise).
3. Clone your fork of the mpf repo to your local machine (`git clone https://github.com/YOUR_GITHUB_HANDLE/mpf/`)
4. Install MPF dependencies if you did not install mpf before. On linux you can run our installer <https://raw.githubusercontent.com/missionpinball/mpf-debian-installer/dev/install-mpf-dependencies>. On other platforms check the [installation instructions](#) instructions.
5. Run `pip3 install -e .` from within the mpf folder to install MPF in editable mode.

6. Clone your fork of the mpf-mc repo to your local machine (`git clone https://github.com/YOUR_GITHUB_HANDLE/mpf-mc/`; only needed for media controller changes - skip otherwise).
7. Install MPF-MC dependencies if you did not install mpf-mc before. On linux you can run our installer <https://raw.githubusercontent.com/missionpinball/mpf-debian-installer/dev/install-mc-dependencies>. On other platforms check the [installation instructions](#) instructions.
8. Run `pip3 install -e .` from within the mpf-mc folder to install MPF MC in editable mode (only needed for media controller changes - skip otherwise and just run `pip3 install mpf-mc --pre`).
9. Switch both repositories to the branch corresponding to the version you want to work with. This should be dev in most cases or the current release for smaller bug fixed. Do what works best for you. We can help to forward or backport your changes.
10. Create a local branch to work on (`git checkout -b your_feature_name`).
11. Make your changes.
12. Add your name to the AUTHORS file.
13. If possible add an unit test. We can help with that and a first Pull Request without a test is definitely fine.
14. Run `python3 -m unittest discover -s mpf.tests` and check that all tests still pass. You achieve the same for mpf-mc with `python3 -m unittest discover -s mpfmc.tests`.
15. Commit your changes (`git commit -a`)
16. Push your changes to your github (`git push origin your_feature_name`).
17. Create and submit your pull request on github.

We recommend you to use a decent IDE because it makes life easier. Most of the MPF developers use PyCharm but other IDEs will work as well.

Getting started with an open issue

We maintain a list of issues which are self-contained and good to solve on their own without too much interaction with core code. We label those as [help wanted](#) (although they do not have to be easy, just self-contained). If you want to work on one of them (or any other issue) comment on the issue or write in the forum and we will assist you along the way.

Contributing to MPF's Documentation

Want to help make these docs better! Great! We'd love any help, whether it's as small as correcting a typo, adding to a section that isn't clear, adding your own How To guide, or whatever else you want to change.

To make a quick change to an existing page

Quick changes to existing pages can be done right on the web!

To do that:

1. Browse to the page you want to update, and click the "Edit on GitHub" link in the upper right corner of the page.
2. Click the pencil icon in the upper-right corner of the page's text. (If this is grayed out, that means you need to create a GitHub account and/or login.) This will create a fork of mpf-docs in your GitHub account.
3. Make your change, and click the "Propose file change". This will create a pull request. Type a name describing your change, and click "Create pull request".
4. Details and screen shots of this entire process are [here](#).

To make a suggestion for a new doc (or to point out an error)

Even if you don't feel comfortable actually changing or editing docs, you can still tell us about an error in the documentation or suggest new documentation that we should add. To do this:

1. Go to the "Issues" [page of the mpf-docs repository on GitHub](#).
2. Create a GitHub account if you don't have one, and/or login.
3. Click the "New Issue" button and describe what you'd like us to fix or add!

To clone the mpf-docs repo locally to make bigger changes

If you want to make bigger changes to the docs, or if you want to download the mpf-docs repo so you can work on it offline, do the following:

1. Clone the [mpf-docs repo](#) from GitHub.
2. Switch to the branch corresponding to the version of the docs you want to work with.
3. Make your changes.
4. Add your name to the `/authors/index.rst` doc.
5. To test the docs locally, you'll need *sphinx* and *sphinx_bootstrap_theme*, both of which you can install via *pip*.
6. Run `make html` to ensure everything builds properly without any additional warnings from whatever docs you added or changed. (The built docs will be in the `_build/html` folder. You can open *index.html* in your local browser to preview your changes.
7. Submit your pull request.

Since MPF is a work-in-progress, we're making a lot of changes and progress with dozens of code updates per week.

The links here explain how MPF version numbering works, what features are in what versions, and a roadmap of ideas and plans for the future.

The latest released version of MPF is 0.33.x, but the documentation you're reading now is valid for MPF versions 0.30-0.33.

Understanding MPF version numbering

This page explains:

- How version numbering works in MPF, and
- How the MPF documentation versions map to the MPF versions.

MPF is under constant development. The core developers typically spend a combined 40 hours a week working on MPF with multiple fixes and enhancements made every day. You can see the stream of code "commits" on GitHub, [here for MPF](#) and [here for MPF-MC](#). (Actually we work on the docs a lot too, check out the latest updates [here](#).)

Anyway, we release a new version of MPF about every 6 months. (See the full release history [here](#)).

MPF version numbering follows a standard called [semantic versioning](#) which uses a "MAJOR.MINOR.PATCH" version number format. For example, the version number 0.31.8 is major version 0, minor version 31, and patch number 8.

Note: Version numbers in MPF are numbers separated by dots which are *not* mathematical decimals. In other words, MPF 0.30 is "zero point thirty", which is not the same as "0.3" which is "zero point three". Also, 0.30 is 27 versions newer than 0.3.

All the MAJOR versions of MPF start with “0” because we have not yet released a 1.0 version yet.

MPF features and configuration files can change between MINOR versions. For example, there were significant changes between versions 0.21 and 0.30.

The PATCH versions are bug fixes only which do not have functional or config file changes. So 0.30.0, 0.30.1, and 0.30.11 are all the same in terms of documentation and features. (Also 0.30.11 is ten patches newer than 0.30.1.)

You can see which version of MPF you have by adding a `--version` option to whatever command you use to launch MPF. For example:

```
mpf --version
```

Since MPF is actually two projects (MPF and MPF-MC), all of this version stuff applies to both of them. (Typically you’ll use the same MAJOR.MINOR versions of both, but the PATCH number might be different. For example, the latest MPF version might be 0.31.11 while the latest MPF-MC version could be 0.31.8. That’s fine.)

You can see which versions are the latest released versions at any time by visiting the [MPF Users Google Group](#) where we list the latest versions in the header of the page.

Documentation Versions

Since MPF versions are constantly changing, we’re also constantly adding and improving the documentation.

Generally speaking, each documentation set covers multiple MPF versions. You can see the current version(s) of MPF the documentation you’re reading is for by looking for the version numbers in the blue box in the upper left corner under the Mission Pinball logo of any page on the documentation site.

If you’d like to access documentation for an older version of MPF, you can click the “Read the Docs” link in the lower left corner of any page.

If you look in the URL for a page, you’ll see the version(s) of MPF that page is for. Note that there’s a special version of the docs called “latest” which always points to the latest version of the docs. (That way you can safely link to a page and know that in the future it will always be the most recent version.)

MPF Version History

Here’s the history of the various release versions and changes of the Mission Pinball Framework. (Patch releases and bug fixes are not included in this list.)

0.50

Currently in Dev, plan in time for Chicago Pinball Expo October 2017

MPF

New Features

- TBD

MPF-MC

New Features

- TBD

0.33

April 10, 2017

MPF

New Features

- “Ball hold” device (Temporarily hold a ball while something else is happening)
- “Multiball lock” device (Track ball locks towards multiball, including virtual locks, across balls and players)
- Multiball “add a ball” feature
- Added support for Stern SPIKE platform
- *Revamped logging*
- Additional achievements control events
- BCP ports & interfaces are now configurable
- Drop target “keep up” feature (PWMs reset coil to “lock” target up)
- “Async” events (Events that wait for all handlers to finish before continuing)
- Additional multiball events
- More functions for people building games to use to write tests
- Built-in modes with code can have their code overloaded
- Added score reels to the smart virtual platform
- Allow machine variables to be set via BCP
- Allow setting default high scores
- Add “early save” events to ball saves
- Add all monitorable device properties to conditional events
- Use placeholders in mode timer start & end values
- More options for bonus (hurry ups, skip slides with 0 value, placeholders for score calculations, etc.)
- Improved ball search
- OPP - support for firmware 2.0 and dual wound coils
- MC scriptlets for video modes and code on the MC side
- Support for conditional events

- Template variables which are evaluated during runtime and can use placeholders (timers, logic_blocks, tilt, scoring, bonus_mode, and more)
- Early ball save
- Advanced bonus_mode
- TimedSwitch device - built-in event for flipper cradling and releasing
- Asynchronous logging - This is especially important on windows because logging previously slowed down the game. However, also important in production when under high I/O load or with slow discs.
- Timers work outside of the game now
- New “mpf diagnosis” command
- Scoring to machine variables
- Scoring for other players
- Weights in random_event_player
- Unlimited delay in ball_save to allow video modes or mode selection
- Added Machine vars for all kinds of versions
- Drop Target keep up support
- Multiball add a ball support
- New multiball_lock device which handles virtual saves for multiplayer game
- Allow BCP to bind on all IPs

Bug fixes & code improvements

- A lot of miscellaneous bug fixes
- Exiting service mode always put the machine back on free play
- Fixed a ball lock crash
- File loader will not try to load temp files
- Manual plunger in smart virtual platform now works properly
- Refactored ball devices to allow for different types of ball counters & be more robust for unexpected ball situations and different types of eject failures
- Made achievements and achievement groups smarter and more robust (also backported to 0.32)
- Improved log messages for BCP encoding errors
- “Hz” setting is gone (since MPF is now tickless)
- Active eject process trackers are canceled on shutdown
- Randomizer now works with a single element
- Fixed a bunch of small things that caused crashes
- Changed default on-screen DMD pixel settings
- Removed OSC plug-in since it hasn’t worked in over a year and no one uses it
- Better errors on invalid configs

- Catching a lot more config problems
- Improved ball search. Drop Target reset no longer resets ball search
- Better start/stop procedures for modes. no more event races
- Improved extra ball
- Better yaml parsing for unescaped strings
- Performance improvements through better fast paths and offloading of logging from the synchronous path
- BCP version 1.1 with synchronisation during reset
- Improved handling of ball devices with entrance_switch
- Force UTF-8 for configs on windows
- Better errors when loading assets

MPF-MC

New Features

- Added a camera widget (live video)
- Allow placeholders and settings
- Added keyboard debugging
- Added warnings if window size & display size aspect ratios are not the same
- MPF-MC now checks to make sure the MPF version it's talking to is compatible
- Change the default display size to 800x600 if a displays: section is not in the config
- Re-vamped Mac installation procedure. It's now a "real" install and does not use MPF.app anymore.
- Added a "volume" machine variable
- Added Interactive Media Controller (iMC)
- Added "anchor_y: baseline" option for text widgets
- Added gamma setting for physical DMDs
- Added new relative animation target values

Bug fixes & code improvements

- Improved sound asset loading speed (uses SDL_Mixer for loading to memory rather than GStreamer)
- Sound assets can be loaded while videos are playing
- Sound assets can be located in sub-folders as many levels deep as desired (not just a single level)
- Fixed points widget
- Improvements to automated testing on Travis
- widget_player positioning fixed
- Better error messages for malformed slide configs

- Prevent crash in text widget when empty and back is selected
- Changes to support BCP 1.1

0.32

Dec 1, 2016

MPF

- Improved *achievements* and added *achievement groups*.
- Added relay events and relay queues
- Improved *smart virtual platform*
- Improved support for *System 11* and *Gottlieb System 3 style* troughs (including using the ball drain as a ball storage location to get one additional ball capacity with no hardware changes).
- Verify that duplicate sections don't exist in config files
- Check that event handlers are properly formatted before they're registered
- Added conditional events (handlers that only fire if certain conditions are met)
- You can *set starting values for player variables*
- Fixed the *physical mono DMD* and *physical RGB (color) DMD*
- Added *multiball lost event*
- Allow devices to have inline config specs
- Added shots with events
- Better OPP platform parsing
- Fixed & improved the high score mode
- Improved service mode
- Added options for "random" events (force next, force all, save per-player, etc.)
- Added events to the BCP monitor (meaning they can be viewed in the MPF Monitor app)
- Added -f command line option to force all assets to load on boot for testing purposes
- Added *scoring* options (add, replace, block)
- Use color "on" for LED default colors
- Allow multiple config player entries to fire from the same event
- Ensure that events created by the MC are sent to MPF
- Added machine vars for P-ROC and FAST hardware revisions
- Added *combo switches* (for "flipper cancel", two-button skill shots, etc.)
- Lots of little bug fixes. . .

MPF-MC

- Fixed the widget z-order layering bug (this has been backported to 0.31). Widget orders are now higher value z: settings are on top of lower value ones.
- Negative z: values are no longer used to target parent slide frames. Instead, target: (name) is used.
- Cleaned up debug logging so BCP frames are not included in it by default
- Events that are natively posted in the MC are now sent to MPF
- Fixed a bug to ensure that the slide_active event is only posted once per frame
- Fixed a bug that prevented slide frames from being animated
- Fixed a bug where videos were not stopping
- Allow the same slide to be used on multiple displays
- Switch to GStreamer instead of SDL_Mixer for loading and streaming sounds. (SDL2 still used for all sound output.)
- Sound file streaming is now supported from any track (streamed from disk instead of preloaded into memory)
- New “track_player” config controls sounds at the track-level (fade, volume, play, pause, stop, etc.)
- Custom loading & unloading events at the individual sound level.
- Lots of little bug fixes. . .

0.31

Sept 19, 2016

MPF

- MPF is now “tickless”, meaning everything runs faster, but with less overhead
- Improved flow control for FAST hardware serial communication
- Improved BCP communications
- Improved serial communications for all devices which use serial
- Additional options for ball saves
- Removed many threads which makes everything simpler and faster under the hood
- Improved “virtual” and “smart virtual” platforms
- Prevent broken data files from crashing MPF
- Added a basic service mode (this is just a start, much more to come)
- Detect balls that jump between playfields
- Prevent duplicate rules being written to P-ROC and P3-ROC controllers
- Allow mode config files to be broken into multiple files

- Allow multiple multiball modes to run at once and add options for how it tracks them
- Allow ball locks to wait for a ball to drain before releasing their locked balls
- Added the ability to use matrix lamps/LEDs at individual channels for RGB LEDs
- Re-added high score mode (Which was in 0.21 and removed in 0.30)
- OPP platform improvements
- Improved error messages for config file errors
- Improved the way the “mpf both” command works on all platforms
- Added ability to step backwards in shows
- Refactored and improved show player
- Added ball search for servos
- Added default colors to RGB LEDs
- Added support for nested shows
- Added the “LED Group” device (an easily-configured strip of LEDs which can be strobed, pulsed, etc.)
- Added kickback mechanisms
- Added magnets
- Added blocking show queues
- Many bug fixes. . .

MPF-MC

- Audio library improvements (sound fading, markers, start position, instance limiting, ducking improvements)
- Allow widget events based on when slides are shown, hidden, etc.
- Improved error if you try to target a widget to an invalid slide
- Added default DMD fonts
- Many bug fixes. . .

0.30

July 15, 2016

- Python 3 required
- Mac OS X support
- The Media Controller is now a separate package from MPF
- The MPF-MC has been completely rewritten from scratch (based on Kivy, SDL2, OpenGL, and Gstreamer)
- GPU is used for graphics

- Brand-new audio interface specifically written for pinball audio, which includes advanced feature like ducking, attack, attenuation, etc.
- Proper Python package installers, and inclusion in PyPI so install can be done via *pip*.
- System-wide *mpf* launcher utility with pluggable commands
- New MPF clock module replaces the old timing and timers
- All shows are driven by MPF
- Show content is “played” by the standard `config_players`
- Playlists become shows
- “Tocks” are gone, shows now operate on real-world time
- Light scripts are gone, replaced by placeholder “tokens” in shows
- Named colors
- Hardware accelerated LED fades
- Asset Pools
- Ball Search
- Accelerometer-based tilts
- Servo support
- Text string support
- Player achievements

0.21

Dec 1, 2015

- SmartMatrix “real” RGB LED Color DMD support.
- System 11 support.
- High Score mode.
- Credits mode.
- Tilt mode.
- Smart virtual platform. (This is the new default platform.)
- New display elements: Character Picker and Entered Characters.
- Devices can be created and changed per mode.
- Machine variables.
- Untracked player variables.
- Central config processor, data manager, file manager, and file interfaces. This paves the way for config files in formats other than YAML.
- Added support for combo manual/auto plungers.
- Events for ball collection process.

- Driver-enabled devices.
- External light shows, controllable via BCP. (Thanks Quinn Capen!)
- Created a starter game machine config template you can use for your own machines.
- Started adding unit tests. (We're at the very beginning of this, but we have full coverage of the ball device, the event manager, and the tutorial configuration files.)
- Rewritten driver/coil device interface.
- Rewritten ball device and ball controller code. (Thanks Jan Kantert!)
- Rewritten score controller.
- Rewritten display & slides modules.
- Many improvements and features added to ball saves.
- Python 2.7 is now required. (Previous releases would also run on Python 2.6)
- Logic blocks can now persist between balls
- Fixed & enhanced the asset loading process.
- Many improvements and features added to modes and the mode controller
- Multiple config files can be chained together at the command line
- Improved text display element.
- Improved event manager and event dispatch queue
- Moved all utility functions to their own class.

0.20

Sept 14, 2015

- The *targets* and *shots* modules have been combined into a single module called *shots*.
- The new shots module adds several new features, including:
 - Shots can be members of more than one shot group, and added and removed dynamically.
 - Sequence shots can track more than one simultaneous sequences. (e.g. two balls going into an orbit at essentially the same time will now count as two shots made.)
 - Shots are mode-aware and will automatically enable or disable themselves based on modes starting and stopping.
- Modes now work outside of a game.
 - "Machine modes" have been removed. Attract and game machine modes are now regular modes.
 - This makes it easier to have always-running modes (volume control, coin door open, coin & credit tracking).
 - This makes it possible to configure custom branching of mode-flow logic. (i.e. long-press the start button to load a different game mode, etc.)
- Significant performance improvements for both starting MPF and starting a game:
 - Reading the initial states of switches on a P-ROC is significantly faster.

- The auditor now waits a few seconds before writing its audit file, and it does it as a separate thread. Previously this was slowing down the game start and player rotation events.
- The way modules that need to track “all” the switches (like the auditor and OSC) was changed and now it doesn’t bog things down.
- A device manager now manages all devices. (This will enable future GUI apps to easily be able to browse the device tree.)
- Devices can be “hot added” and removed while MPF is running. This includes automatic support to add and remove devices per mode.
- All device configuration is specified and validated via a central configuration service. This has several advantages:
 - The config files are now validated as they’re loaded. For example, if there a device has a settings entry for “switches”, MPF will now validate that the strings you enter in the are actual switch names. It will give you a smart error if not.
 - This paves the way for supporting config files in formats other than YAML. (JSON, XML, INI, etc.)
 - This led to the removal of about 500 lines of code since all the config processing was done manually in each module before.
 - The config processing is more efficient and less-error prone since it’s not written from scratch for each module.
 - There’s now a master list (in *mpfconfig.yaml*) of all config settings for all device types.
 - The config processor and validator can run as a service to support the back-end business logic behind future GUI tools which could be used to build machines.
 - If you’re configuration has an unrecognized setting, the config validator will load the config file migrator to tell you what the updated name is for the section it doesn’t recognize.
- Shot rotation has been improved:
 - You can now specify the states of shots you’d like to include or exclude. (i.e. only rotate between incomplete shots.)
 - You can specify custom rotation patterns (i.e. a “sweep” back-and- forth instead of a simple left or right rotation)
- A ball lock device was added to make it easy to specify ball locks.
- A multiball device was added.
- A simple ball save device was added.
- Created a “random_event_player” that lets you trigger random events based on another event being posted.
- Centralized debugging
- Drop targets and drop target banks have been simplified and separated from shots.
- The states of switches tagged with ‘player’ will be passed to the game start mode, allowing branching based on which combinations of switches were held in when the start button was pressed. (The amount of time the start button was held in for is also sent.)
- Official support for multiple playfields via config files

- Added x, y, and z positions to lights and leds
- Exposed wait queue events to mode configs, allowing code-less creation of modes that can hook into game flow (bonus, etc.)

0.19

August 6, 2015

- Completely rewritten target and drop target device module, including:
 - Per-player state tracking for targets
 - Target “profiles” that control how targets behave, completely integrated with the mode system
- Light show “sync_ms” which allows new light shows to sync up with existing running shows.
- Timed switch events can be set up via the config files.
- Added “recycle_time” to switches. (Switches can be configured to not report multiple events until a cool-down time has passed.)
- Created an events_player module
- Player variables in slides automatically update themselves when they change. (No more need to find an event to tie the slide to in order for it to update!)
- Device control events exposed via the config files
- Automatic control of GI
- Activation and deactivation events can be automatically created for every switch.
- Allow multiple playfield objects to be created at once (for head-to-head pinball)
- Added support for FAST Pinball’s new WPC controller
- Added a Linuxshell script to launch mc.py and mpf.py
- Created the config file migration tool
- Added per-timer debug loggers
- Standardization of many non-standard config file naming conventions
- Color logging to LEDs
- Added P3-ROC switch test tool
- Added reset to mode timer action list
- Added restart feature to mode timers
- Flipper Device: Add debug logging to rules
- FAST: Added minimum firmware version checking for IO boards
- Added “restart” method to logic blocks
- Text display element min_digits
- Allow system modules to be replaced and subclassed
- Added configurable event names for switch tag events

- Added callback kwargs to switch handlers
- Added light and LED reset on machine mode start
- Added default machine and mode delay managers

0.18

June 2, 2015

- FadeCandy and Open Pixel Control (OPC) support. This means you can use a FadeCandy or other OPC devices to control the LEDs in your machine.
- Rewritten FAST platform interface. It's now "driverless," meaning you no longer need to download and compile drivers to make it work.
- Added support to allow multiple hardware platforms to be used at once. (e.g. LEDs can be from a FadeCandy while coils are from a P-ROC.) You can even use multiple different platform interfaces for the same types of devices at once (e.g. some LEDs are FadeCandy and others are FAST).
- Added support for GI and flashers to light shows
- Added activation and deactivation events to switches
- Added support for sounds in media shows
- Added per-sound volume control
- Added support for P-ROC / P3-ROC non-debounced switches
- Exceptions and bugs that cause MPF to crash are now captured in the log file. (This will be great for troubleshooting since you can just send your log. No more needing to capture a screenshot of the crash.)
- If a child thread crashes, MPF will also crash. (Previously child threads were crashing but people didn't know it, so things were breaking but it was hard to tell why.)
- MPF can now be used without switches or coils defined. (Makes getting started even easier.)
- "Preload" assets loading process is tracked as MPF boots, allowing display to show a countdown of the asset loading process
- Added *restart_on_complete* to mode timers
- Smarter handling of player-controlled eject requests while existing eject requests are in progress
- *eject_all()* returns *True* if it was able to eject any balls
- Playfield "add ball" requests are queued if there's a current player eject request in progress
- Created a smarter asset loading process
- The attract mode start is held until all the "preload" assets are loaded
- Updated how the game controller tracks balls in play

0.17

May 4, 2015

- Broke MPF into two pieces: The MPF core engine and the MPF media player

- Added support for the Backbox Control Protocol (BCP)
- Added device-specific debugging for LEDs.
- Added version control to config files.
- Added volume control.
- Switches that you want to start active when using virtual hardware are now added to the *virtual platform start active switches:* section instead of being a property of the *keyboard:* entry.
- Converted several former plugins to system modules, including shots, scoring, bcp, and logic blocks.
- General performance improvements. (Running MPF on my machine used to take about 50% CPU. Now it's down to 15%.)

0.16

April 9, 2015

- Added slide “expire” time settings to the Slide Player.
- Added *Demo Man* as the sample game code.
- Added start_time configuration parameter for music in the StreamTrack
- Added the SocketEvents plugin
- Created the LightScripts and LightPlayer functionality.
- Change light script “time” to “ticks”
- Created a centralized config processing module

0.15

March 9, 2015

- Added support for game modes.
- Converted several existing modules to be mode-specific, including:
 - LogicBlocks
 - SoundPlayer
 - SlidePlayer
 - ShowPlayer
 - Scoring
 - Shots
- Created an Asset Manager and converted the images, animations, sound, and show modules to use it instead of each handling their own assets.
- Created an asset loader which creates a background thread to load each type of asset.
- Added an AssetDefaults section to the asset loader to specify per- folder asset settings
- Created a universal player variable system

- Added movie support (for playing MPEG videos on the LCD and DMD). They're available as a standard display element type which means they can be positioned, layered as backgrounds, etc.
- Created a generic ModeTimers class that can be used for timed modes and goals. (With variable count rates, support for counting up and down, multiple actions which can start, stop, pause, and add time, etc.)
- Changed logic blocks so they maintain all their states and progress on a per-user basis.
- Added a "double zero" text filter. (Used to show zero-value scores as "00" instead of "0".)
- Updated the display code so that it doesn't show a slide until all that slides assets have been loaded.
- Renamed the "sphinx" folder to "docs".
- Broke the three phases of machine initialization into 5 phases.
- Created the mode timer
- Renamed the "HitCounter" logic block to "Counter" and updated it to be more flexible so it can track general player-specific counts (both up and down), for example, total shots made, combos, progress towards goals, etc.
- Changed window section of config so it uses the slide builder.
- Added the ability to control lights and LEDs by tag name in shows.
- Modified the switch controller so events from undefined switches simply log a warning rather than raises an exception and halting MPF.

0.14

February 9, 2015

- Completely rewritten ball controller.
- Completely rewritten ball device code.
- Major updates to the diverter device code.
- Creation of a new playfield module that's responsible for managing the playfield and any balls loose on it.
- Completely rewrote the "player eject" logic. (This is what happens when the game needs to wait for the player to push a button to eject a ball from a device.)
- The ball search code was moved from the game controller to the playfield device module.
- Different types of events were broken out into their own methods. For example, to post a boolean event, instead of calling *event.post(type='boolean')*, you now use *event.post_boolean()*. There are similar new methods for other event types, like *post_relay()* and *post_queue()*.
- Added a debug option for ball devices which enables extra debug logging for problem devices.
- Tilt status was removed from the machine controller. (It was inappropriate there. Tilt is a game-specific thing, not a machine-specific thing.)
- Virtual Platform: default NC switch states fixed

0.13

January 16, 2015

- Major update to the sound system, including:
 - Support for multiple sound tracks (“voice”, “sfx”, “music”, etc.), each with their own channels, settings, volume, etc.
 - Using background threads to automatically load sound files from disk in the background without slowing down the main game loop.
 - Support for streaming sounds from disk versus preloading the entire sounds in memory.
 - Support for sound priorities and queues, so sounds can pre-empt other sounds if they have a higher priority.
 - System-wide volume control with settable steps.
- Support for the v1.0 update of FAST Pinball’s libfastpinball library. (Basically we updated the FAST platform interface to support their latest firmware and drivers)
- Support for flashers. (Previously flashers were just driven like any other driver. Now they are their own device with their own flasher- specific settings.)
- Game Controller: Changed the player rotate routine to be driven from the game_started event so the player object isn’t actually set up until the game has finished being set up.
- Pygame: Moved the Pygame event loop to the machine controller and out of the window manager. This lets us use Pygame events even if we don’t have an on screen window. (This is needed for the sound system.)
- Display: Moved the SlideBuilder instantiation earlier in the boot process so it’s available to other modules who want to use it when they’re starting up. This will let us get the “loading” screen up earlier in the boot process.
- Switch Controller: Added a method to dump the initial active states of switches to the log. This is needed for our automated log playback utility so it can set the initial switches properly.
- Ball Devices: fixed a typo on the cancel ball request event

0.12

December 31, 2014

- Added full display and DMD support, with support for physical DMDs, on screen virtual DMDs, color DMDs, and high res LCD displays.
- Added transitions which flip between display slides with cool effects.
- Added decorators which are used to “decorate” display elements (make them blink, etc.)
- Added display support to shows so that shows can now combine display and lighting effects
- Added a Slide Builder which can assemble slides from text, image, animation, and shapes from shows and the config files.
- Added a SlidePlayer config setting which can show slides based on MPF events
- Modified the Virtual DMD display element so that it can render on screen DMDs that look more like real pixelated DMDs

- Added a font manager that lets you define font names and specify default settings (sizes, antialias, color, etc.)
- Added TrueType font support
- Added support for stand image types to be displayed on the DMD
- Added .dmd file type support for images and animations
- Added the OSC Sender tool
- Added the Font Tester tool
- Added the multi-language module which can replace text strings with alternate versions for multi-language environments and other (e.g. “family-friendly”) text replacements
- Improved the diverter devices so they have knowledge of what ball devices and diverters are upstream and downstream, allowing them to automatically activate and deactivate based on where balls need to go.
- Improved the ball device class so ball devices are smarter about how they interact with target devices. (e.g. a ball device will automatically eject a ball if its target device wants a ball.)
- Added support for the P3-ROC
- Added many more events
- Modified displays so they can each have independent refresh rates

0.11

December 1, 2014

- Created a Display Controller module which is responsible for handling all interactions with all types of displays, including DMD, LCD, alphanumeric, 7-segment, etc.
- Created a DMD display module which controls both physical DMDs as well as on screen representations of physical DMDs
- Created a Window Manager, a centralized module which manages the on screen window, including full screen and resizable support
- P-ROC platform interface: Built the DMD control code
- FAST platform interface: Built the DMD control code
- Switched from Pyglet to Pygame
- Created a Sound Controller
- Created a Game Sounds plug-in that lets you control which sounds are played and looped based on MPF events
- Added PD-LED support
- Added support for P3-ROC SW-16 switch boards
- Switch Controller: Added `verify_switches()` method which verifies that switches are in the hardware state that MPF expects.
- Switch Controller: Adding logging so it can track when duplicate switch events were received
- LEDs: added `on()` and `off()` methods and “default color” support

- Ball Device: created `_ball_added_to_feeder()` and made it so the device watches for a ball entering and will request it if it needs it.
- Changed the command line options so you don't have to specify the `.yaml` extension for your configuration file
- Changed the command line options so you (optionally) don't have to specify the "machine_files" folder location
- Created default `machine_files` folder location settings in the config file
- Added support for absolute or relative paths in the command line options
- Added support for X/Y coordinates to LEDs and Lights for future light show mapping awesomeness.
- Created an early, early version of the Playfield Lights display interface which lets you "play" Pygame shows on your playfield lights
- Added system default font support
- Added a player number parameter to the `player_add_success` event
- Added a default MPF background image for the on screen window
- Added many more default settings to the system default `mpfconfig.yaml` file
- Virtual platform interface: Updated it so that it works when hardware DMDs are specified in the config files

0.10

October 25, 2014

- Added `enable_events`, `disable_events`, and `reset_events` to devices.
- Removed the First Flips plug-in. (Since the thing above replaces it)
- Added support for network switches and drivers for FAST Pinball controllers.
- Added support for multiple USB connections to FAST Pinball controllers to separate main controller traffic from RGB LED traffic.
- Changed default debounce on and off times to 20ms for FAST Pinball controllers.
- Individual targets hit in target groups will now post events
- Changed the default show priority to 1 so it will restore lights that weren't set with a priority by default
- Driver: Added a power parameter to `driver.pulse()`
- Score Reel: Added resync events to individual reels
- Score Reel: Changed `repeat_pulse_ms` config setting to `repeat_pulse_time`.
- Score Reel: Changed `hw_confirm_ms` config setting to `hw_confirm_time`.
- Changed default pulse time for all coils to 10ms
- Coils: (Fast): Added separate `debounce_on` and `debounce_off` settings
- Info Lights: Forced `game_over` light to off when game starts

- LEDs: Added force parameter to the off() method

0.9

October 7, 2014

- Added a “Logic Blocks” plug-in which lets game programmers build flowchart-like game logic with the config files. No Python programming required!
- Created a “First Flips” plug-in which you can use to get your machine flipping as fast as possible. (This was written as part of our Step-by-Step Tutorial for getting started with MPF.)
- Added Tilt and Slam Tilt support. (This is built via our Logic Blocks, so they’re very advanced, supporting grouping multiple quick hits as a single hit, settling time (to make sure the plumb bob is not still swinging when the next ball is started, etc.).
- Added Extra Ball / Shoot Again support
- Created OSC interfaces for /audits
- MAJOR rewrite to the ball controller and ball device modules
- Created a non-instrumented optimized software loop which is as lean as possible if you’re running your game on a slow computer. (I’m looking at you Raspberry Pi!) Note: other single board computers are fine, like the BeagleBone Black or the ODOID, but man the Pi is slow.
- Added the ability to pull “data” from MPF via the OSC interface, so we can put player scores, ball in player, etc. on an iPhone, iPad, or Android device.
- Added an OSC audit interface so you can view audit data via your mobile device.
- Created an “Info Lights” plug-in which turns on or off lights automatically based on things that happen in the game. (Which player is up, current ball, tilt, game over, etc.) This is typically used in EM games, but of course the plug-in can be used wherever you need it.
- Finished the code for our Big Shot EM-to-SS conversion. This is included as a sample game in MPF, so you can see our config files and
- Logic Blocks which can be helpful when creating your own game.
- Fixed up drop targets to support the new lit/unlit scheme
- Added support for default states to targets and target groups (stand ups, rollovers, drop targets, etc.), including events that are posted when they are hit while lit or unlit, and the ability to light or unlight them via events
- Added Start Button press parameters which are automatically sent to the game when the start button is pressed. This is for things like how long the button was held and what other buttons were active at the time. (Start * Right Flipper, etc.)
- Added a “pre-load check) to plug-ins that allows them to test whether they’re able to run before they load and only load if everything checks out. (This means that a plug-in will no longer crash if a required Python module is missing.)
- Added ‘no_audit’ tag support. (If you add ‘no_audit’ as a tag to a switch, then the Auditor will not include that switch in the audit logs.)
- Created Action Events for shutting down the machine and added shutdown tag support (so you can cleanly shut down the machine simply by posting an event or pressing a button which is tagged with “shutdown”)

- Added performance data logging to the machine run loop (so it now tracks the percentage of time spent doing MPF tasks, hardware tasks, and idle).
- Added a reload() method to Shows which causes that show to reload itself from disk. This is nice for testing shows since you can reload them without having to restart the machine each time.
- Added support for null steps in shows (literally a step that performs no action). This makes it easier to get timing right for music shows.
- Added the ability to force a light or LED to move to a given state, regardless of its current priority or cache.
- Added a method to test whether a device is valid. This will be used for our config file validator
- Added option for restart on long start button press
- Added option to allow game start with loose balls
- Score reels maintain a valid status, allowing other modules to know whether the score reels are showing the right data or not.
- Score reels now post an event when they're resyncing, allowing other modules to act on it. (For example the score reel controller uses this to turn off the lights for a score reel while it's resyncing.)
- Added option to remove all handlers for an event regardless of what their registered ****kwargs** are.
- Added mpf command line options for verbose to console and optimized loops. (Now we can support different logging levels to the console and log file, meaning you can configure it so you only see important things on the console but you can see everything in the log file.)
- Added light on/off action events
- Added action events and methods to award the extra ball
- Created ball device disable_auto_eject() and enable_auto_eject() methods. This is how we handle player-controlled ejects (like when a ball starts or they're launching a ball out of a cannon).
- Changed scoring from "shots" to "events"
- Changed the hardware rules for clearing a rule so it disables any drivers that were currently active from that rule
- Updated are_balls_gathered() so that if you pass it a tag which doesn't exist, it always returns True
- Added management of switch handlers to machine modes so they can be automatically removed
- Changed switch handlers so they process delays from new handlers that are added
- Removed "standup" target device type (it was redundant with "target")
- Moved auditor, scoring, and shots out of system and into plugins

0.8

September 15, 2015

- Platform support for FAST Pinball hardware
- RGB LED support, including settings colors and fades

- Created target and target group device drivers for drop targets, standups, and rollovers (including events on complete, lit shot rotation, etc.)
- Created an OSC interface to view & control your pinball machine from OSC client software running on a phone or tablet
- Changed our “light controller” to a “show controller” and added support for things other than lights (like coils and events). So now a show can be a coordinated series of lights, RGB LEDs, coil firings, and events.
- Created an “event triggers” plugin which lets you configure series of switches that trigger events, including custom timings, decays, and resets. (We use this for our titlt functionality but it’s useful in other ways too.)
- Created the auditor module
- Created an intelligent diverter device driver (with hardware switch trigger integration)
- Created GI device drivers
- Created a system-wide MPF ‘defaults’ configuration file
- Created templates for new machines, new scriptlets, and new plugins
- Modified the on screen window to become a “real” LCD display plugin.
- Renamed “hacklets” to “scriptlets”
- Created a scriptlet parent class to make them even easier to use
- Broke the hardware module into “platforms” and “devices”
- Major rewrite of how the machine controller loads system modules and devices
- Shows now auto load
- Added the ability to attach handlers to lights so you can receive notifications of light status changes
- Reworked the EM score reel update process to simplify and streamline it

0.7

September 4, 2014

- Support for lights and light shows.
- An on-screen display of game metrics like score, player, and ball number.
- A “hacklet” extension architecture which lets you add python code to finish up the “last 10%” of your game that you can’t control via the machine configuration files.
- A formal plug-in architecture which allows easy creation and modification of plug-ins that will survive core MPF framework updates.
- Cleaned up the machine flow and made that controllable via the config files
- Changed the -x command line option so it doesn’t use fakepinproc, got rid of the p_roc methods that detected fakepinproc. (Now even with the P-ROC platform it will use our virtual platform interface when no physical hardware is present. This means you don’t need pyprocgame to use fakepinproc.
- Changed the command line options to break out machine root from config files

- Moved command line options to their own python dictionary
- Changed `time.clock()` back to `time.time()` since clock was not real world which affected the light shows
- Created new events to capture start and stop of machine flow modes
- Added light support to P-ROC platform interface
- Reorganized the machine files into machine-specific subfolders
- Created an `int_to_pwm()` static method in Timing

0.6

August 19, 2014

- Addition of a Shot Controller, allowing you to configure and group switches which become shots in the machine. (Read more about the concept of shots in our blog post from last week.)
- Addition of a Scoring Controller, allowing you to map score values to shots (and general scoring support for the machine).
- Addition of the Score Reel Controller, Score Reel devices, and Score Reel Group devices for mechanical score reels in EM-style machines. (Details [here](#).) Switched entire framework timing over to real time system clock times (`time.clock()`) instead of ticks (for delays, tasks, switch waits, etc.)
- Changed ball controller that if it counts more balls than it thought it had, it will invoke `ball_found()`
- Changed the switch controller so it will ignore new switch events if they come in with the current status the switch already is
- The switch controller will ignore repeat switch events from the hardware if they are the same state that the switch was in before
- Added chime support for EM-style machines
- Changed `game_start` event to a queue
- Change `game_start` event name to `game_starting` (some of these entries might seem trivial, but I also use this list to track the changes I need to make to the documentation)
- Created a queue for adding new tasks so our set won't change while iterating

0.5

August 5, 2014

- Created a single device parent class that's used for all devices.
- Rewrote and cleaned up devices. Now coils, switches, and lights are all devices, as are the more complex ones.
- Added "events" to the keyboard interface. This means you can use the keyboard to post MPF events (along with parameters).
- Separated out ball live confirmation and valid playfield

- Built a bunch of valid playfield methods
- Changed ball_add_live_request from direct calls to events so they'd be slotted in properly
- Broke valid playfield out into its own module
- Made the ball device "entrance" switch work
- Built a quick "coil test" mode
- Added kwargs to event handlers (meaning you can register a handler with kwargs)
- Figured out how to handle the "first time" counts of ball devices
- Added checks to attract mode to make sure all balls are home, and to the ball controller to prevent game start if all balls are not home
- Changed ejects to events. (So if you want to request that a device ejects a ball, you post an event rather than calling the device)
- Changed the balldevice_name_eject_request to be the event you use to call it, rather than the notification of the eject attempt.
- Created a get_status() method for ball devices
- Created a gather_balls() method and wrote the code that will send all the balls home before a game can be started.
- Updated stage_ball() code so it didn't ask for another ball if there was already an eject in progress
- Moved detection of how balls fall back in out of devices and into the events that watch for the entrance
- Create player and event based ejects. (This is a system to allow players or events to eject balls from ball devices. Useful for cannons like in STTNG.)
- Got stealth and auto eject out of the ball device code since they shouldn't care about that.
- Rewrote a lot of the ball device stuff.
- Added a manual eject capability for devices without eject coils
- Moved around some things between the ball controller and ball devices so that everything lives where it 'makes sense'
- Added method to check whether an event has any handlers registered for it.
- Ball devices now post events based on tags when balls enter them
- Ball devices can now eject their ball if no event is registered. This will prevent balls from getting "stuck" in unconfigured devices and will make prototyping on new machines faster.
- Changed event logging to show "friendly" names of handlers
- Converted flippers to use a config dictionary instead of variables
- Cleaned up the eject confirmation and valid playfield functionality
- Added a remove_switch_handler method to the switch controller

0.4

July 25, 2014

- MAJOR rewrite of how the hardware platform modules interact with the framework's hardware module and how hardware is configured in general. It's way simpler and cleaner now. :)
- Created a parent class for Devices
- Cleaned up the way hardware objects use their parent class
- Fixed the ball controller so it doesn't get confused on the initial count after machine start up.
- Cleaned up switch processing and added a logical parameter so we only have to do all the conversion for NC or NO in one place
- Renamed the none interface to virtual. Rewrote it with the new platform interface way of working.
- Added support for holdPatter in coils
- Change add_live() to use tags instead of the plunger device
- Made it so many things, like ball search, autofires, etc. would not crash the machine if they weren't there.

0.3

July 16, 2014

- Changed the way config files are loaded by making Config a normal section of any config file instead of using a special initial configuration file that did nothing but point to additional files. Details [here](#).
- Created a virtualhardware platform for virtual / software only testing that does not require P-ROC or FAST drivers.

0.2

July 11, 2014

- Added docstring documentation
- Added /sphinx folder and got the sphinx html docs included
- Created the first version of the documentation

0.1

June 27, 2014

- Command line parameters to select real or fake (simulated) controller hardware.
- Command line parameters to select logging level
- Command line parameters to select the location of the initial config file
- Reads an initial config file which is a list of additional config files

- Processes those config files in order to build a config dictionary
- All platform-specific hardware code is isolated into its own module. Config files specify which platform is used. All game code is 100% interchangeable between platforms.
- Game loop runs with configurable loop rate. System timer tick event is raised every tick.
- Periodic and one-time use timers can be setup
- Switches, Coils, Lamps, and LEDs are read in and configured from the config files
- Switch events are read from the hardware
- Driver commands can be sent to the hardware
- Autofire drivers are automatically configured from the config files. They can be enabled, disabled, and reconfigured as needed.
- Flippers are automatically configured based on config files. They can use EOS or not, and be based on two coils (main/hold) or one coil with pulse+pwm. Multiple coils can be connected to the same switch, and vice-versa.
- The computer keyboard can be used to simulate switch presses. Key map configuration information is stored in the config dictionary. It supports momentary, toggle (push on / push off), and inverted (key press = open) key modes. Also supports combo key mapping (Shift, Ctrl, etc.)
- A switch controller receives all notifications of debounced hardware switch events.
- Can specify timed switch modes that trigger certain methods. (i.e. do blah() when switch_1 is active for 500ms.)
- Event manager handles system events, including registering handlers, priorities, aborting events, and maintaining a queue.

MPF Road Map, Vision & Future

To set the stage for our vision for the future of MPF, we'd like to start by saying that we love "traditional" pinball where you hit knock a physical ball into real targets.

While there's lots of talk about alternate concepts like Pinball 2000 and the Multimorphic P³ (which replaces the bottom 2/3rds of the playfield with an LCD), our vision is focused on traditional-style pinball machines.

That said, we believe there is quite a bit of room for innovation even within the boundaries of classic pinball. For example:

Internet-connected pinball machines that report their own outages & problems

One of the problems with pinball on location today is that the machines often break. Unfortunately since most of these machines are owned by route operators, if a pinball machine in a bar breaks then the bartender just turns it off and the route operator has no idea that it's not earning. So if the operator is stopping by once a week to check on a machine, it might break an hour after he leaves and then be dark (and not earning) for the next 6 1/2 days until he comes back again.

We believe that pinball machines should be able to use the internet to report their current status. The operator should be able to log into a web portal to see all his machines and to view the current status. He should get text messages or iOS alerts with details of the "credit dot."

Furthermore, the ultimate indicator of whether a machine is working or not is whether it's earning. If a pinball machine only earns \$20 a week, it's literally not worth an operator's time to drive to the location to check on it. So if he can see a report that the machine is earning as expected, he wouldn't have to waste his time and gas driving around to all his locations to check on his machines.

We can also be proactive when machines are turned off. The operator ought to be able to configure a schedule which basically says, "This machine should be powered on from noon until 2am every day," so if the cloud service ever loses connectivity with a machine during those hours, it can notify the operator (and maybe the location owner) that the machine is offline when it should be on, and the operator can make a phone call to see if the machine is ok before heading out. (And, if the machine is not ok, the operator can know that he's going out to the location for a reason.)

Of course there are plenty of times when a machine is powered on with no credit dot, but where the machine might still not be playable. (Maybe there's a stuck ball or a broken rubber.) In those cases we can go back to the earnings reports. If a machine is typically earning 5 dollars per day but half a day goes by without any money inserted, the machine can alert the operator that there's a problem.

Dynamic Pricing

Another cool thing about an internet-connected pinball machine is that operator settings can be centrally "pushed" to the machine. If a bar is rented out for a private party, the bar tender ought to be able to fire up an app on his or her smart phone to instantly set all the machines to free play. Or maybe there's an automatic schedule. "Wednesday night is free pinball," or "All pinball is free from 4-7pm." The operator ought to be able to set up a schedule and the machines should be able to change their pricing automatically based on the time of day.

We could even imagine "demand pricing," where the price is automatically adjusted up or down based on demand for a particular machine.

Player "Log in" for notification of high scores being beat

We love the idea of players being able to "log in" to a machine, most likely by "tapping in" to the machine with their Bluetooth or NFC-enabled smart phone. (This idea is not new of course. Pyprocgame creator Adam Preble [blogged about this in 2014](#), and Dutch Pinball's Bride of Pin*Bot 2.0 and Big Lebowski have "Player Profiles" features.)

Regardless of how it's implemented, we love the idea of a particular player being able to login to a machine, since there are several cool things this could enable, including:

- Notification of high scores being beat. How cool would it be if you could get a text message or iOS notification when you lost your high score spot on your favorite machine?
- Accomplishments tracking. I would love to know what my high score was on different machines, or for a mobile app to tell me, "That's the most combos you've ever completed in Attack from Mars."
- Player preference settings. Most pinball machine settings are geared towards operators (number of balls per game, difficulty, etc.), but modern machines have plenty of options that don't matter to operators that hard core players are very passionate about. A pinball machine's app should allow players to set their own white balance for RGB LEDs (cool versus warm white), or the overall brightness of the LEDs, or even whether the LEDs "pop" on-and-off instantly or gently fade up and down like traditional incandescent bulbs. Players should be able set these preferences on their own or save their to their profile which they can have applied to whatever machine they walk up to.

All of this could be done on a per-player basis, with the machine taking on a different look and feel as each player steps up. Players could even set their color preferences with RGB LEDs in the apron lighting to indicate which player is up.

Mobile phone companion apps

We've already [demonstrated a feature](#) of the Mission Pinball Framework where we use an iPhone app as a "second screen" for a pinball machine. We can imagine players being able to customize their iOS app to show whatever data they want—score, ball, shots lit, etc.—which they can then set on the glass near the flippers. The machine could also send all DMD information and animations to that device and the player wouldn't have to take their eyes off the flipper area.

The mobile app could have a "helper" mode where it knows exactly what's going on in the game and can tell you what to shoot for—kind of like if you had a world-class player standing over your shoulder and telling you what to do.

The mobile app could also let you know when it's your turn (in case you walked away from the machine), or when a certain machine you're waiting in line for is free. (Maybe you even pay for and "reserve" your place in line from your phone?)

It could also let you see all sorts of statistics for your game when while another player is playing (balls locks, goals remaining, etc.).

You'd also be able to collect very detailed metrics and analytics about your games. (Average time to hit a hurry-up, average ball time, number of shots, etc.) That could also be shared in a web-based dashboard and player ranking system.

Mobile phone audio integration

One of the things that stinks about playing pinball in a loud bar is that you can't hear the machines. Some machines have headphone jacks, but that's a separate piece of hardware.

What if you could pair your phone to the machine, and then the machine could stream its audio to your phone which you could listen to via headphones? You could even allow multiple people standing around to connect their audio to the same machine?

Another option is if you pair your phone with a machine, you could play a playlist from your phone instead of the machine's music. The pinball machine could still add the voice call outs and sound effects, but just with your music. (This could be done via headphones or even through the pinball machine's speakers.)

The machine could even have a mobile app which lists all the various music cues (waiting to plunge, base mode background, wizard mode background, etc.) and you could map those to individual tracks from your phone. Then whenever you walk up to a machine, you get your own custom music! (This could integrate with a cloud-based music service like Spotify or Apple Music and be configurable via the web so you get your own music any time you play that machine.)

Mobile phone "waiting player" actions

Traditional multi-player pinball machines alternate between players, with the non-playing players just watching the current player that's up. The games themselves are very much about the "player versus the machine" more so than the "player versus player."

But what if the waiting player could use their phone to mess with the current player who's up? Maybe they have buttons that could temporarily shut off the flippers, or pop up drop targets which block shots, or release extra balls into play, or turn off all the lights. . .

These could be things that are granted to each player (you get one of each per game), or they could be earned by players for accomplishing certain achievements during the game.

Social media integration

Like it or not, people love posting random stupid things to social media, and their latest accomplishments on some pinball machine in a bar fit nicely into that. We can imagine a pinball machine tweeting high scores and jackpots made, perhaps even with a tiny camera in the top of the backbox which sends photos winning (and losing) moments to the players.

Most locations that have pinball machines also have social media accounts, and they struggle with ways to get their customers to "connect" with them. An internet-connected pinball machine could be part of that. Maybe they give players a free game (which they can redeem by tapping in with their phone) if the player lets the pinball machine tweet a photo of them winning.

"Offline" goals

An internet and social media connected pinball machine can also keep the relationship with the player going even when they're not at the machine. Maybe a player has to play a Facebook game or engage with a brand to "unlock" certain features of the game. Or maybe that's reversed, where people who play massive online games have to seek out a real world pinball machine to unlock certain goals in their online game.

Promos & advertising

We briefly mentioned the concept that locations could change their machines' pricing around special events and for happy hours. But why stop there? What if an advertiser, desperate to reach the 18-to-35 year old male, could buy their potential customers a free round of pinball? Imagine that tied to location services with the pinball players' app. You walk by a bar and your phone buzzes and it says "Lexus would like to buy you a free pinball game if you walk into this bar in the next 10 minutes." (Of course this is something that the bar could do too. Come in now and get a free game of pinball with every pint you buy.)

We could also imagine in-game advertising, maybe between balls or even integrated within the game. (Maybe a game has multiple pricing tiers, with the 25-cent game add supported while the 75-cent game remains "pure.")

Pinball only costs 75 cents or a dollar to play, and there are many types of advertising today where the advertisers pay far more than a dollar per impression. A pinball ad network could charge the advertiser one dollar per game, and the location and operator would make the same money they always did, the ad network could take their cut, and there would still be enough left over to increase the revenue a pinball machine could generate overall.

In-app purchases for game credits and power-ups

Even in 2014, we notice a lot of our friends saying, "I don't have any quarters," as an excuse not to play pinball. What if you could buy credits via an in-app purchase? There could be options for credits

that expire, credits that are only good for one machine or one bar, bulk pricing discounts, and even credits that never expire. You could even structure it like a public transit card where a player's credits are automatically topped up when the balance gets low.

This could be used for much more than just credits. Players could buy options like extra balls, longer ball saves, tilt forgiveness, and other in-game goals all from their phones. The machines could keep track of which games used which options (important for keeping fair high scores), and the additional revenue could be shared with the location and operators.

Buh-bye four-button service menus!

It probably goes without saying that the four-button tap-tap-tap-tap-tap-enter-tap-tap-tap service menu is going to be history. Every pinball machine moving forward should have a mobile app for operators that lets them configure settings and few reports and audits in an easy-to-use interface on the mobile device.

Even if they're not sitting at their machine, operators should be able to connect to a website to see all their machines, view Google Analytics-style earnings reports, remotely update software, push out configuration settings, and manage all aspects of the machine. Leaning down behind a coin door to configure things is almost laughable for a new machine in today's world!

Advanced tournament options

One of the problems with tournaments today is that if a machine malfunctions, it can break the current game in progress which isn't really fair to the current players.

What if the machine could maintain a sort of "transaction log" of everything that happened, so if a machine malfunctions, the tournament operator could hit a button to pause the machine, reset the ball or fix the problem, roll back the errant entries, and resume the game?

You'd also be able to integrate the actual machine scores and players with the tournament system. Super Selfie Leagues could automatically post scores and notify players when their scores have been beat or when they move down on the leaderboard.

Accelerometer integration

Modern machines with accelerometers can use them to track g-forces as well as to know the precise angle (in 3 axes) of the machine.

This means that the machine could notify the operator if the machine was not level. And when you were leveling the machine, it should show you that level on the display, or even read it out with text-to-speech as you were underneath the machine adjusting the legs.

The machine could also record the playfield angle for high scores (especially those posted online, maybe along with tilt sensitivity and outlane settings) to start to get a more universal baseline to high scores. (Though it still wouldn't be perfect due to wear, playfield wax, etc.)

The machine would also know if someone was lifting up the front of the machine (even slightly), which could make for some funny callouts. Maybe the points start draining until the player sets the machine down again.

You could even have a machine that can apply scoring multipliers based on the angle. (And maybe even have a machine where you can set the angle and scoring on your own?) Imagine “My high score on Ghostbusters is 200M at 6.5 degrees, but only 25M at 7 degrees.”

More ideas from Jon Norris

Since we first wrote down our vision, someone let us know that pinball designer Jon Norris wrote about a bunch of ideas for innovation in classic pinball too. You can see his ideas at norrispinball.com. (Some are in the blog and some are in the “Re-Inventing” section of his site.)

Lots of cool stuff there too!

The future is bright!

One of the things we love most about pinball is that it’s a real, physical thing. Traditional arcade games have lost much of their earnings power because everyone has a PS4 and 60” tv at home. But most people don’t have pinball machines at home. And even though there are pinball apps for every device out there (which we LOVE, by the way), it just doesn’t compare to actually banging a metal ball around with some mechanical levers.

Maybe it goes without saying, but we consider everything on this page to be our “to do” list for the Mission Pinball Framework.

The best part is that the Mission Pinball Framework is highly modular, so if you think some (or all) of these ideas are stupid, that’s fine with us! You can pick-and-choose the parts of MPF that you like and throw out the rest.

Finally, we understand that a lot (ok, everything) we talked about here only applies to new pinball machines moving forward. But what about the hundreds of thousands of existing machines which are already in the world based on 20-year old technology? We have some ideas for them too. . . stay tuned!

Happy pinballing!

Late 2016 Update

We originally wrote this vision when we started MPF back in 2014 (though it’s been updated since then). In late 2016, Jersey Jack Pinball announced [Dialed In!](#), a machine that has some of the features we wrote about in our vision. At Expo, someone asked us if we were upset that Jersey Jack “ripped us off”. Our answer is quite the opposite. We’re thrilled! We love these ideas and love that they’re making their way into pinball. (And frankly we hope that Stern and everyone else does these too.)

Everything about Mission Pinball is open and available for sharing, use, and ripping off. Take our ideas. Take our code. Copy our docs. We love it all!

D

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